

IRQ/DMA
CONFLICTS

FREE POSTSCRIPT PROGRAM — BRM CARDS

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TEST LAB REVIEWS

- Hard Cards
- Optical Storage Drives
- Data Compression Boards
- Post Card Troubleshooters



SOFTWARE

- Utility of the Month: Norton 6.01
- File Compression: AutoDoubler, Double Disk, Expanz Plus, PKZip, Stacker, SuperStor

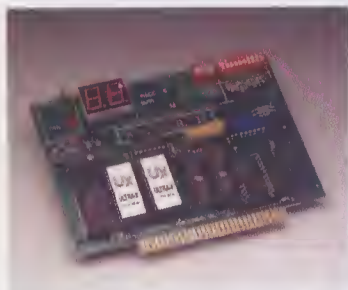
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The Troubleshooters

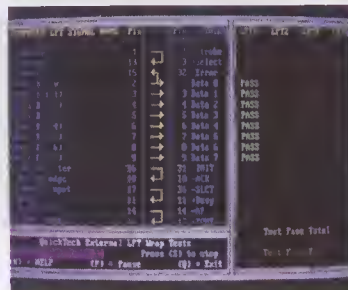
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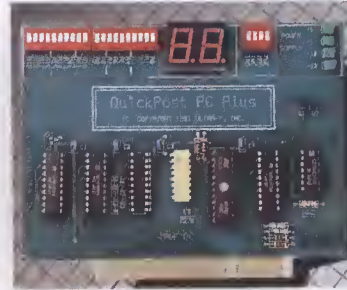
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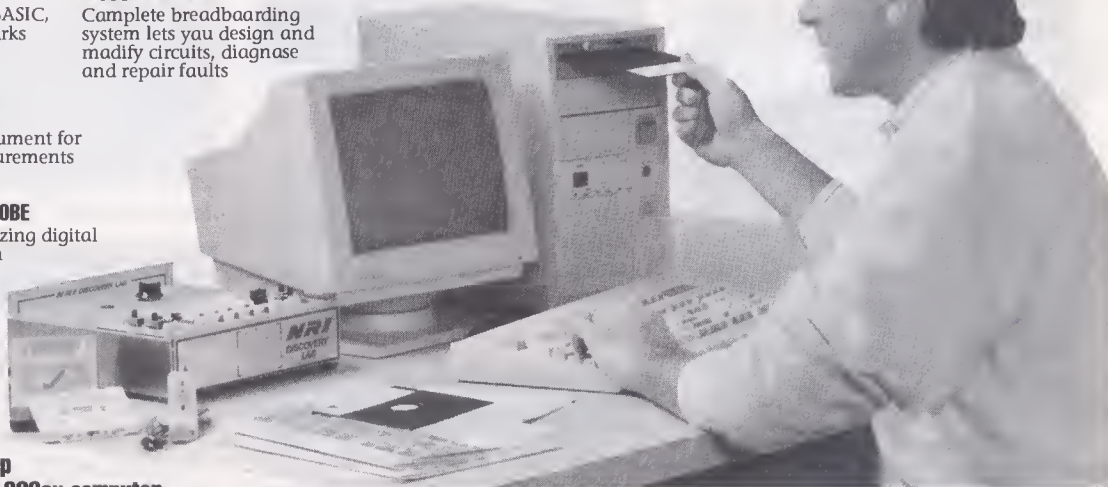
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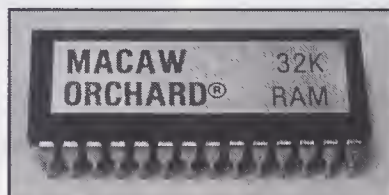
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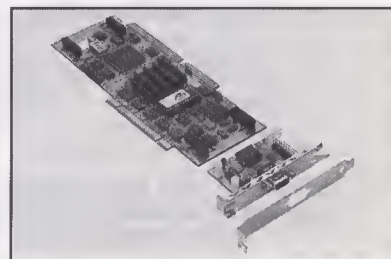
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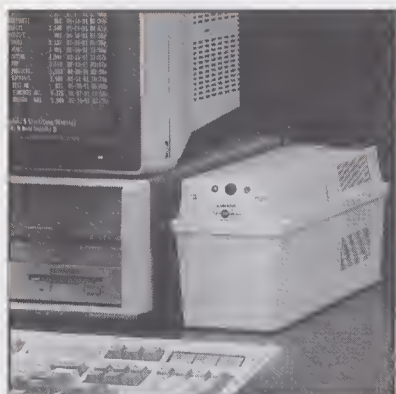
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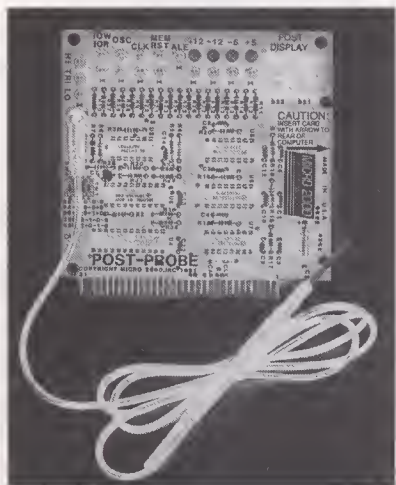
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The more you know about interrupts and direct memory access, and how they work, the more success you'll have when adding hardware to your PC.



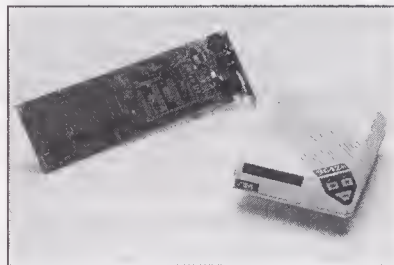
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If you're running out of expansion capability inside of your PC and you still need more storage capacity check out these high capacity hard cards. They might be just what you need. Unfortunately, it is not always as easy as plug and play.

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This month PC Upgrade editors check

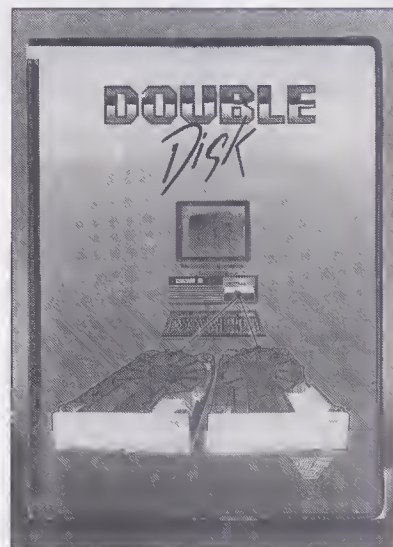


out the relative speeds of 14.4, 9600 and 2400 baud modems and make a startling discovery, thanks to data compression, buying a 14.4 modem may not save you a great deal of money or time.

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Cover Design by Emerson-Wajdowicz, New York City.

Customizing Your PC

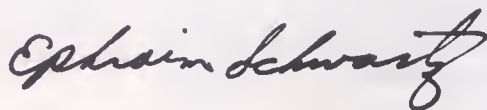
At the risk of sounding cynical, we would like to know what all the fuss is about customizing your PC. Suddenly major manufacturers are talking about putting together systems as the customer directs rather than offering models with configurations cast in stone.

Wake up, computer industry: your customers have been doing it for years. And those that couldn't order more RAM, a second or even third drive, a special video board, a better keyboard, or whatever else they wanted from the manufacturer went out and did it themselves. So now that customizing a PC seems to be the trend among major manufacturers, does that mean you won't ever have to open the case again and do it yourself? Fat chance!

Take a good look at the contents of this issue and you'll see that manufacturers can't customize a PC the way the average business person wants for one simple reason: The products keep changing. You can buy your mail-order PC with tape drives, 16Mb of RAM, a gigabyte of storage, and a SuperVGA monitor today, only to be told tomorrow that you should have a local bus, a video accelerator card, a new BIOS, a faster modem, and 32Mb of 50 nanosecond RAM!

The industry continues to grow, innovate, and develop new products to match the power of new operating systems, multimedia requirements and ever more powerful and useful software. Therefore, in addition to covering the newest products, PC Upgrade will also feature the kind of how-to information you'll need to add these products to your system.

Manufacturing cycles require at least six months from the time a product enters the consciousness of manufacturer and consumer until it is part of the newest system. By that time, it may already be outdated. One of PC Upgrade's very reasons for being is to show you how to upgrade to the most current equipment immediately before manufacturers add it to the systems they offer.



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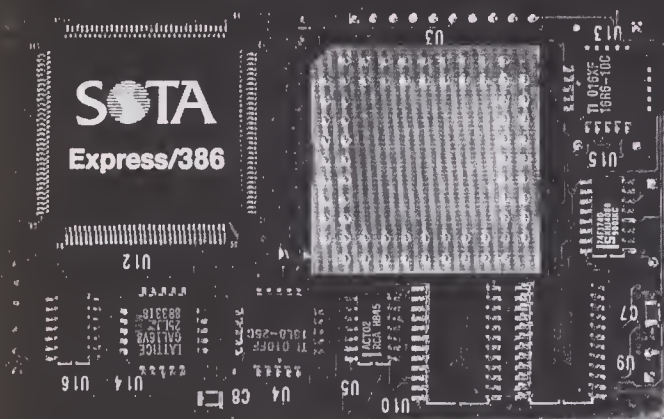
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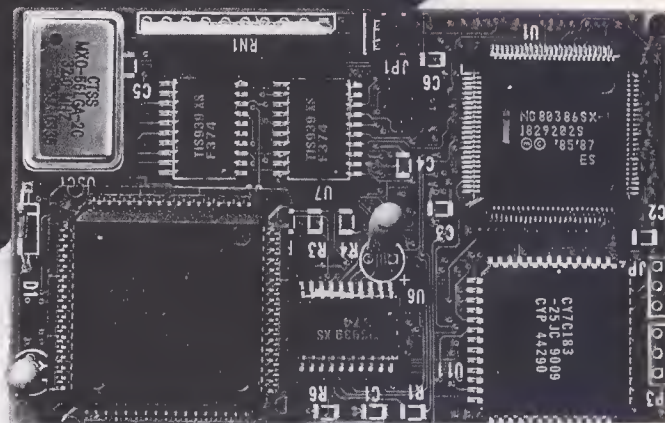
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SOTA Express/386



ACTUAL SIZE - FRONT



ACTUAL SIZE - BACK

The 386sx upgrade for your 286 computer is here at last! The SOTA Express/386 is a credit-card sized accelerator which speeds up your 80286 system up to 300%. It adds either 16 or 32K of cache and allows you to run 386 specific software. By plugging directly into the 80286 CPU socket, this unique accelerator does not occupy a valuable expansion slot in your system.

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80386sx SPEED

Greater speed and memory management capabilities are becoming increasingly crucial with today's powerful software packages. The SOTA Express/386 breathes new life into your AT by replacing the 80286 CPU with the 80386sx architecture, immediately improving your system's performance up to 300%. The Express/386 comes with 16 or 32K of zero wait state cache to squeeze maximum performance out of your machine. The cache is 2-way set-associative cache, which, unlike ordinary "direct map" cache, is a "smart" cache. It determines which data is no longer needed and replaces it with more useful information.

FUNCTIONALITY

The SOTA Express/386 enables you to expand your software library to include the latest 386 software. Run Windows 3.0 in the 386 enhanced mode and enjoy true multitasking and background processing! Alternatively, run 386Max, QEMM or VM/386 and get the most out of your system's memory. The SOTA Express/386 also features support for a 80387sx coprocessor for all math intensive applications.

COMPATIBILITY

This powerful accelerator is compatible with virtually all 80286 machines, from IBM PC-ATs and compatibles to PS/2s Models 30-286, 50 and 60 running up to

16MHz. With the SOTA Express/386, you are assured of compatibility with all boards in your system as well as present and future 286 and 386 software. The Express/386 is ideal for corporate markets where different machines with a wide variety of enhancement boards typically coexist.

CONVENIENCE

The SOTA Express/386 offers the most convenient way to upgrade your system to a 386sx. While preserving your hardware investment, you eliminate the need to reload any software, rewire any networks, or hassle with the complicated replacement of your motherboard. More importantly, you avoid all hidden costs and are guaranteed compatibility.

DRIVERS AND UTILITIES

The SOTA Express/386 comes equipped with a software driver which initializes the board and provides Video and BIOS caching. Utilities that allow for RAM disks, print spooling and disk caching are also provided.

INSTALLATION

The SOTA Express/386 is surface mounted on both sides to occupy minimal space in your system. Simply remove the 80286 processor, plug the SOTA Express/386 in the empty socket and enjoy the speed and functionality of a 386 system...at a fraction of the cost!

Introducing

Mac Upgrades

By Edward Schneider

I'm not going to go into the details now (I already have, in our sister publication *Computer Buyer's Guide and Handbook*), but the four-year old Cirrus hard disk in my Mac II started to get flaky a while ago. This caused all manner of disquieting problems, including some corrupted files, a few of which remain unusable.

The conventional wis-

dom, with which I am not inclined to argue, is that once a hard disk starts to fail it is unlikely to be permanently rejuvenated, so after fiddling around with various stop-gap solutions, I finally decided it was time to look into a new hard disk.

I decided too that it was time to move up in terms of speed and storage space, and after examining vari-

ous price-versus-performance considerations I opted for a 325Mbyte internal drive from Storage Dimensions (which makes a full range of internal and external drives for all extant Macintoshes, as well as a NuBus SCSI enhancer they call the Data Cannon).

I made a nice fresh backup of my old, physically challenged drive (with the vague, superstitious hope in the back of my mind that this would somehow uncorrupt my broken files—it didn't, of course) and popped the top off my Mac II, having years ago thrown away the single, superfluous screw that Apple places in the rear, presumably for the sake of appearances. This involved shifting a monitor and a pile of SCSI devices that topped and surrounded the computer, which in turn involved tugging on a Gordian knot of untraceable cables; if I had the capacity to learn lessons of this kind, I'd have learnt that it really does pay to keep your cables neat and identifiable. I pass this on in the hope you are more susceptible to improvement than I am.

Swapping Drives Physically, it is a cinch to remove and/or install hard drives in Mac II-family computers. They vary in configuration, but access is always easy. The original-edition Macintosh II has a metal platform that supports both hard and floppy drives; the bracket attached to the hard disk simply slots into this platform and is secured by a couple of screws. Most hard disks come with at least two different brackets; make sure you choose the right one for your computer. Or, if you are replacing an older hard disk, you can reuse the old bracket; the computer will be used to it and it might bring you good luck. Or bad luck. Luck, anyway.

Apart from dropping the drive into place, all you have to do is make the data and power connections; the former is achieved with a ribbon cable, the latter with a four-connector cord ending in a flattish plug made of white plastic (these cables are generally supplied with the drive, but if you are upgrading it is easier to use the ones already connected to the motherboard from the last time).

(continued on page 33)

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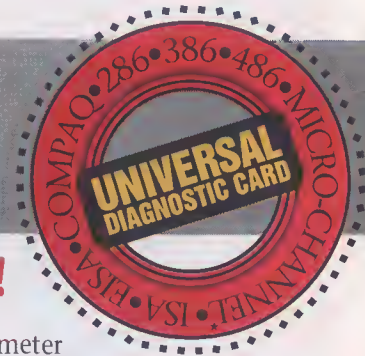
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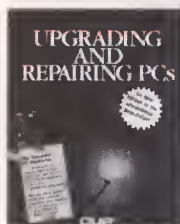
Here's what Scott Mueller,
author of *Upgrading and Repairing PCs*,
has to say about

POST-PROBE™

1ST EVER UNIVERSAL POST CARD FOR ALL PCs!



The only card you need to debug any "dead" PC!



I have found POST Code [Power On Self Test] cards invaluable in diagnosing what seem to be "dead" motherboards. Just pop the card into a slot, and observe the code on the card's display. The documentation supplied

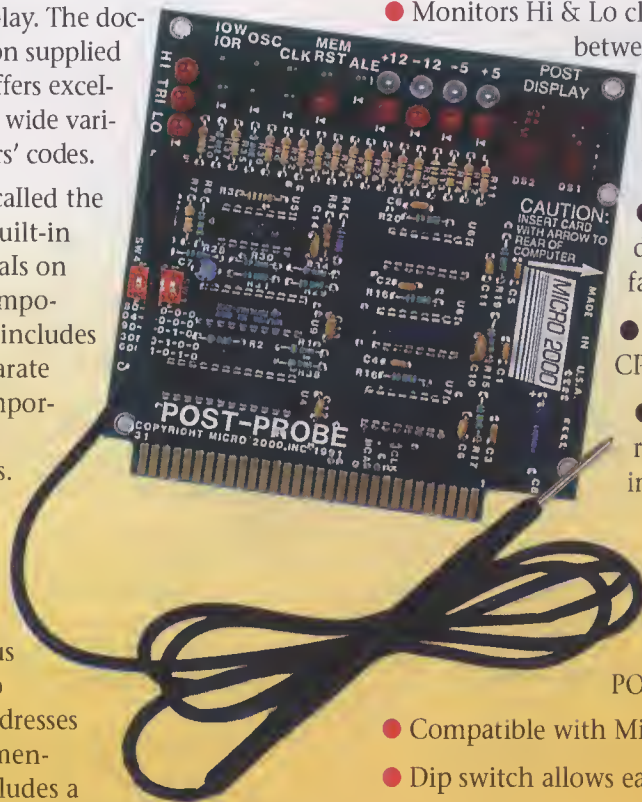
with the Micro 2000 card offers excellent information covering a wide variety of different BIOS vendors' codes.

"The Micro 2000 card (called the POST-PROBE) includes a built-in logic probe for testing signals on the major motherboard components. The Post-Probe also includes a series of individually separate LED readouts for several important bus signals as well as power supply voltage levels. The separate LED's allow monitoring of these bus signals simultaneously.

"The basic card functions in all ISA and EISA bus systems due to its ability to monitor any of the Port addresses mentioned previously. As mentioned earlier, this card includes a unique adapter that allows it to function in MCA bus systems as well.

"This is the only card that will function in every system on the market. The documentation is extensive, and not only covers the expected POST Codes for different BIOS versions, but also includes a detailed reference to the bus signals monitored by the card.

"There is also a reference that allows even a novice to use the included logic probe for some more sophisticated motherboard tests. This card offers more features than others currently on the market." —Scott Mueller



- Includes pads for voltmeter to attach for actual voltage testing under load.
- 4 LEDs monitor +5vdc -5vdc +12vdc -12vdc.
- Monitors Hi & Lo clock and OSC cycles to distinguish between clock chip or crystal failure.
- Monitors I/O Write and I/O Read to distinguish between write and read errors.
- Monitors memory write/read to distinguish between address line failures and memory chip failures.
- Monitors ALE for proper CPU/DMA operation.
- Monitors Reset to determine if reset is occurring during POST, indicating short.
- Monitors progress of POST without POST codes.
- Reads POST codes from any IBM or compatible that emits POST codes. ISA/EISA/MCA.
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It's All Happening at the Swap Meet

Sunday Monday Tuesday Wednesday Thursday Friday Saturday

August

2

August 2, 1992

Ham Radio and Electronics Swap Meet
Las Positas College,
Livermore, CA 7:00am-12:00pm
North off at Hwy. 1-580, at Airway Blvd.
exit, follow signs.
415-462-5055

9

August 9, 1992

The Sacramento Computer Show & Sale
Sottish Rite Temple
6151 H Street
From I-80m exit H St, right on H to
location, corner of Carlson & H. From
Hwy 50, exit Howe Ave. North. North on
Fair Oaks, cross river and it is 2nd
building on right.

MarketPro Computer Shows and Sales
Civic Auditorium
Oxnard, CA
Admission Is \$6 To All Shows,
10:00am-5:00pm
For Futher Information on These Shows
Please Call 415-388-8893

16

August 16, 1992

MIT Electronics Research Society
Albany and Main Street, Technology
Square,
Cambridge, Mass. 9:00am-2:00pm
617-253-3776

MarketPro Computer Shows and Sales
Centennial Hall
Hayward, CA
Admission Is \$6 To All Shows,
10:00am-5:00pm
For Futher Information on These Shows
Please Call 415-388-8893

8

August 8, 1992

KGP Computer Show
Royal Plaza Trade Center\Hotel
Massachusetts Turnpike to I-495 North
to Exit #24B-1/2 Mile on Right Side
Marlborough, MA 10:00am-3:00pm

Market Pro Computer Shows and Sales
Baybridge Holliday Inn
Emeryville, CA
Admission Is \$6 To All Shows, 10:00am-
5:00pm
For Futher Information on These Shows
Please Call 415-388-8893

15

August 15, 1992

Kitsap County Fair Ground,
Bremerton, Washington
9:00am-5:00pm
(206) 874-8711

22

August 22, 1992

KGP Computer Show
Fairleigh Dickinson University
Rothman Athletic Center, Route 4 to
Hackensack Ave. South-Left At Light
Hackensack, NJ 10:00am-3:00pm

29

August 29, 1992

KGP Computer Show
Raritan Center Exposition Hall, NJ
Turnpike Exit 10
Edison, NJ 10:00am-3:00pm

And here's a calendar of upcoming computer shows and swap meets.

Sunday

Monday

Tuesday

Wednesday

Thursday

Friday

Saturday

6

September 6, 1992

Ham Radio and Electronics Swap Meet
Las Positas College,
Livermore, CA 7:00am-12:00pm
North off at Hwy. 1-580, at Airway Blvd.
exit, follow signs.
415-462-5055

20

September 20, 1992

MIT Electronics Research Society
Albany and Main Street, Technology
Square,
Cambridge, Mass. 9:00am-2:00pm
617-253-3776

27

September 27, 1992

Electronic Flea Market
Lincoln High School, Kneeland Ave.,
Yonkers, NY 9:00am-3:00pm
914-969-1053

4

October 4, 1992

Ham Radio and Electronics Swap Meet
Las Positas College,
Livermore, CA 7:00am-12:00pm
North off at Hwy. 1-580, at Airway Blvd.
415-462-5055

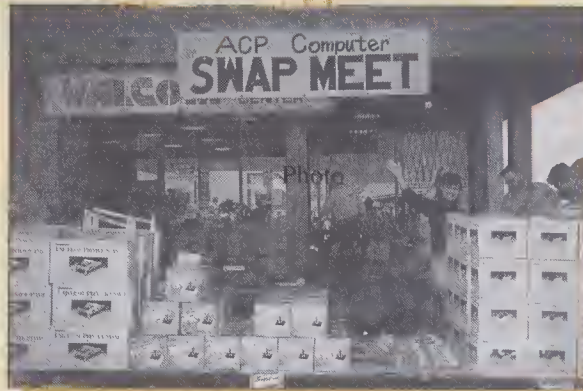
Computer Fest '92 - Fall
Better Living Centre
Exhibition Place
Toronto, Ontario, Canada
Information: (416) 925-4533

18

October 18, 1992

MIT Electronics Research Society
Albany and Main Street, Technology
Square,
Cambridge, Mass. 9:00am-2:00pm
617-253-3776

Hall Of Science Amateur Radio Club,
New York Hall Of Science,
47-01 111Street,
Flushing Meadow, New York
9:00am-3:00pm
718-343-0172



19

September 19, 1992

KGP Computer Show
William Paterson College
Recreation Center, Near I-80, Route
46/23
Wayne, NJ 10:00am-4:00pm

2

October 2, 1992

Computer Fest '92 - Fall
Better Living Centre
Exhibition Place
Toronto, Ontario, Canada
Information: (416) 925-4533

3

October 3, 1992

KGP Computer Show
Royal Plaza Trade Center/Hotel
Mass, Tpke. to I-495 North to Exit #24-
B 1/2 Mile on Right Side

Computer Fest '92 - Fall
Better Living Centre
Exhibition Place
Toronto, Ontario, Canada
Information: (416) 925-4533

A BOOK FOR PEOPLE WHO HATE DOS

by Gordon McComb

Usually, this column is about a DOS tip or technique that saves you time and trouble. This issue, I thought I'd talk about a book that offers sensible tips and tricks of its own, as well as basics for beginners, in a friendly and down-to-earth style.

Most computer books are the same: rather boring and dry. *DOS for Dummies* (IDG Books) strives to break that stereotype, and does a good job at it. Written by computer book veteran Dan Gookin, *DOS for Dummies* is for all those people who hate MS-DOS—the operating system of the IBM PC and compatibles—but have to use it anyway.

Sure, *DOS for Dummies* takes a humorous approach to DOS. But you still learn all the fundamentals. Most importantly, you learn what not to do. Example: Gookin provides a short section of “Never use these dangerous DOS commands” and includes the following for the RECOVER command: “This command sounds healthy, but RECOVER is dumb and deadly...”

DOS for Dummies includes information on the latest version of MS-DOS, version 5.0. Except for a brief mention, it lacks any information on *Windows*. No doubt IDG Books is working on a *Windows for Dummies* book, but such a book isn't available yet.

A LIGHT STYLE AND CARTOON WIT

DOS for Dummies is divided into five sections: Absolute Basics, Non-Nerd's Guide to PC Hardware, Non-Nerd's Guide to PC Software, Yikes! (Or Help Me Out of This One!), an eclectic Section of Tens, and DOS Reference for Real People.

While the book contains a lot of technical specifics, the information is doled out in a light and easy manner. You're never told more than you really need to know. By giving broad explanations, Gookin takes the risk of being imprecise—and therefore not as accurate as he could be—but such lapses never pose anything dangerous. You're always free to supplement the information with a more detailed book.

Scattered throughout *DOS for Dummies* are little icons that direct your attention to important facts: tips, “technical stuff,” and warnings.

Plus there's a sprinkling of funny cartoons drawn by Rich Tennant, a nationally syndicated computer cartoonist. My only complaint is that there aren't enough of Tennant's cartoons.

You'd think that a computer book written in a witty tone, and complete with cartoons, would get tiresome after a while, but this isn't the case. Gookin is careful about the humor and doesn't pour it on too thick. That's a refreshing change from some other books that have attempted to lighten the weighty subject matter of computers with humor. Too often the writer becomes enamored by his own wit. Then, the book falls short of its main intention: to teach you about PCs.

A BOOK FOR BEGINNERS, AND EVEN EXPERTS

The main audience for *DOS for Dummies* is the vast army of people who need to use a computer, but have no interest in making it their life's work. If you're one of these people, then *DOS for Dummies* is probably the only DOS book you'll ever need.

Even if you already know a little bit

about DOS, you may still find *DOS for Dummies* worthwhile. The book contains a handy tear-out reference chart for using important DOS commands, and provides enough tips to keep casual users of PCs happy for a long time.

DOS for Dummies is also useful for the PC pro, not for any advanced information it might provide (which it doesn't), but for the different spin it offers on teaching DOS. Far too often the experts lose touch with the real world, and forget that not everyone lives, breathes, and eats computers.

Reading *DOS for Dummies* gives the experts a chance to appreciate the common confusions and misconceptions beginners often have. If you're in the business of training beginners, *DOS for Dummies* may make an excellent textbook.

USE IT AS A SPRINGBOARD

Of course *DOS for Dummies* doesn't explain it all. And in many instances the over-simplification of technical mumbo-jumbo can raise more questions than those answered. This is only natural with a book of this type.

If you intend to spend any time at all behind a PC keyboard, you'll probably want to graduate to larger and more complex books. Until that time, *DOS for Dummies* is a good stepping-stone to increasing your knowledge of DOS. At least it's one of the fun ways of doing it.

DOS for Dummies, by Dan Gookin
\$16.95; ISBN: 1-878058-25-8
Published by IDG Books
155 Bovet Road, Suite 610
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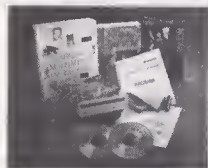
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The

Hardware Doctor

by Sally Grotta

Ghosts, Glitches, And Other Mysteries

You know the drill. There's a squeak or a rattle in your car that you're certain is the precursor to a major motor breakdown, so you drive directly to the repair shop. Only, when the mechanic listens to the engine, it sounds perfect. The noise, of course, immediately returns when you get back on the road.

Like on-again, off-again car noises, the worst kind of computer problem is the intermittent one that happens only when there are no witnesses around. Sometimes you can force a problem to repeat at will, but mostly, it seems to happen at no set time and for no apparent reason. Your system freezes. It temporarily loses its start-up configuration memory. The computer won't boot up, period. Press a particular key and you get a screen full of error messages. But the next time you turn on your system or try the same function, everything works perfectly. What's happening?

In this month's column, we'll discuss some common intermittent computer problems, where they come from and how to eliminate them.

Sometimes My Computer Won't Boot Up

The first time your computer won't boot up, put a floppy disk that has been formatted with the /S (system) switch in drive A. If the computer boots off the floppy, it usually means the beginning of a bad sector on your hard disk drive, right where the FAT

(File Allocation Table) file that stores information on everything on the drive is located. The most frequently used physical area on your hard drive is the location where the FAT file is stored, so it's almost always the first place to suffer wear or damage, and may continue to work or fail intermittently, until it stops working permanently.

There are two ways to fix a damaged FAT file. The first is to use a utility (such as the Mirror function found in *PCTools*) that will create a duplicate FAT file somewhere else on your hard disk, where (presumably) it won't be subject to excess wear. Then, if and when your primary FAT file is corrupted, running this particular program will find the FAT copy and overwrite the bad file.

However, you may experience the same problem again and again, unless you run a low level format utility that will test, pinpoint, and permanently lock out bad sectors or tracks on your hard drive so you can't write data to them that will be corrupted or lost. There are a number of easy-to-use programs, such as *SpeedStor* or *The Norton Utilities*, that allow users to perform low level formats without losing any data from the hard drive. It's a good idea to do a little preventative maintenance by running a low level formatter at least twice a year.

It Won't Boot From The Floppy, Either

Open up your computer case and

check all the cables going from your controller card. Also, look to see if your board is plugged in properly in the slot? Turn your computer on, and look for the red light on the controller board (most, but not all boards have them), to see if it lights up. If it doesn't, you may have a bad board that needs to be replaced.

My Problem Begins Before The Disk Drive Light Goes On

Every computer runs through a startup self-diagnostic routine called POST (Power On Self Test). If it fails the routine, your machine won't boot. Computers fail their POST routines for a number of reasons, from bad memory chips to cracked motherboards (both of which may produce intermittent problems). Usually, the POST will display an error message or number code, to point you to the faulty component. Unfortunately, POST failures are serious and require further diagnostics or a service call from a technician.

When I Turn My Computer On, It Sometimes Goes Directly To Something Called The CMOS Configuration Table

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tor) chip that stores all the configuration data about your computer system: what disk drives you have attached, the correct time and date, the type graphics board you're using, whether your keyboard is being used for French or German characters, and so on. That configuration data was probably input by your vendor or manufacturer before you bought your system. The point is, your default configuration will stay the same until you decide to change it, or until the alkaline or lithium battery feeding power to the CMOS chip runs low.

So, if the configuration table appears occasionally when you boot up, it's probably an indication that it's time to replace the battery (typically, they have to be replaced every 1-3 years, depending on the type). The battery is usually Velcro'd to your computer's power supply, costs from \$7 to \$15, and takes only a minute or two to replace. Actually, you can live without a battery --it won't damage your system--but it's a bother having to reconfigure your computer every time you turn it on.

My Computer Freezes For No Apparent Reason

The most common cause of a computer freeze is dirty power. Every day, every hour, almost every minute, your local electric company is feeding your computer power that is laced with spikes, dips, glitches, peaks, and other electrical hiccups, none of which are particularly good for sensitive electronic components. It's been estimated that better than 95% of all computer problems can be traced to dirty power. Of course, you have a surge suppressor or a power bar that your dealer told you would eliminate most power anomalies, but the fact is it won't. If your surge suppressor cost under \$150, you can be certain that it's missing a lot of anomalies.

The solution is to invest in a heavy-duty, industrial-strength surge suppressor, line stabilizer, or even a UPS (Uninterruptable Power Supply), or better yet, all three. (Some companies sell a three-in-one unit.) Certainly, it's expensive--\$200 to \$800 to properly protect the average computer system--but in the long run, you'll save that and more money on less down time, infrequent lost data and fewer repair bills.

I Have A Good Surge Suppressor, Line Filter, And UPS, Yet My Computer Still Freezes

The other major cause of unexplained, irregular computer glitches is heat. What works well at room temperature can become unstable and unreliable as the temperature rises. Ask yourself: Do your problems usually occur a few minutes after you powered up for the first time that day, or in the afternoon when the sun's heat hits the back of your computer, or when the air conditioner is off? If the answer is yes (and maybe even if it's no), you may have a chip, or a board, or some other electronic component that's particularly sensitive to heat.

Here are some practical solutions to intermittent failures caused by excess heat:

1. Turn up the air conditioning or direct the fan toward your computer.
2. Open the case and look at your peripheral boards. Are they all jammed together? Do you have room to stagger them, so that every other slot is empty? If not, then try to at least separate those boards that contain a lot of memory chips, since they generate the most heat.
3. Install a beefier power supply. The more power your computer needs, the more heat it generates. A 220, 250, or even 300 watt power supply will provide more power without gen-

erating the extra heat.

4. Buy a larger case. A desktop or slimline case is handsome and takes up relatively little space, but it will get very hot if you load it up with lots of memory chips and peripherals. A large tower case will run many degrees cooler.

5. Invest \$59.95 or \$79.95 for the Fancard I or II from Tech Microtech (800-326-3040). The Fancard is, depending on the model, one or two muffin fans mounted on a full-sized expansion board that plugs into any 8-bit slot and provides extra cooling power directly to your peripheral boards. The military used it with great success during Operation Desert Shield, where the temperatures often rose to three digits.

Leave It On Or Turn It Off?

Q: I've heard conflicting reports about whether it is better to leave a computer on or to turn it off when not needed. What happens if I leave my computer on? Is there some period of time when I'm gone when I should shut it off?

Alex Geller,
White Plains, NY

A: Your question is a good one. Unfortunately, opinions vary. Ask a different engineer and you would get a different answer. Overall, we favor leaving the computer on during the

(continued on page 18)

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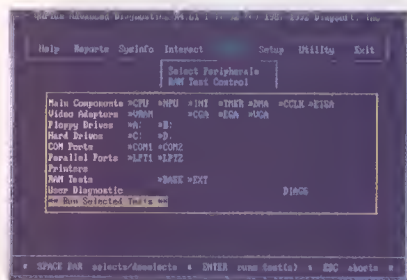


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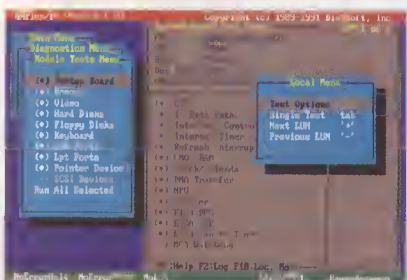
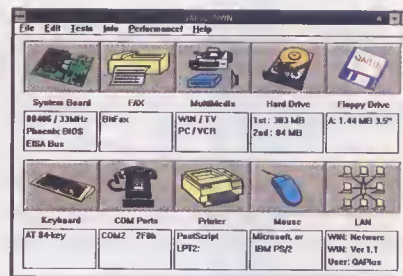


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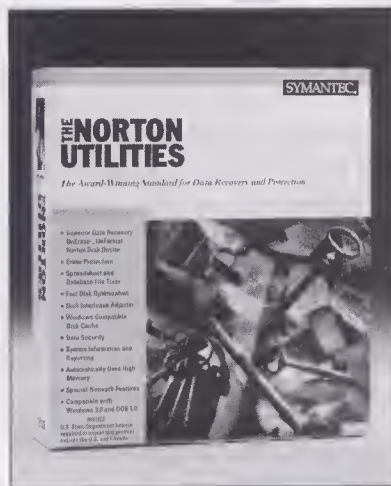
Symantec Corporation

The Norton Utilities v. 6.01

It all began as a no-frills collection of useful little programs that enabled users to restore erased files, sort disk directories, defragment disks, peek at a disk's contents byte by byte, and carry out various other basic procedures. Strange as it may sound, *The Norton Utilities* haven't changed much during the past five years—yet at the same time release 6.01 is quite different from the original package. Symantec has taken great care to improve the programs without breaking with the past.

Many of the programs that compose the collection have been beefed up with a new menu-based interface that supports a mouse and provides context-sensitive Help. Users of older versions, however, fear not: these improvements can be disabled, giving the programs the familiar look and feel of the old *Norton*.

Installing *Norton* is a straightforward process, and the program reports and asks permission for every change it attempts to make to your hard disk. However: *we highly recommend that you read the manuals before attempting to install this package.* *The Norton Utilities* is one of the most useful collections of tools available, but in the hands of an inexperienced user it's one of the easiest ways to really mess up data. All you need to know is in the excellent documentation—a card even warns you *not* to install the package if you bought it in



order to restore your hard disk or recover deleted files.

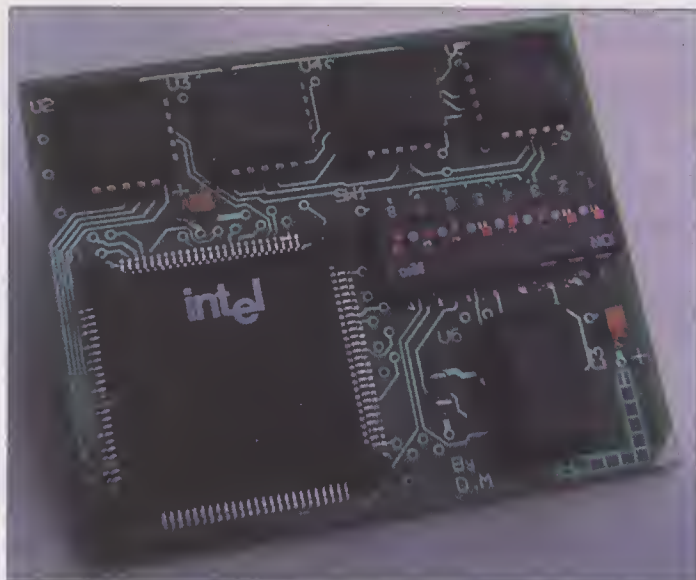
The Norton Utilities now includes programs besides the usual data recovery and disk editing functions: performance enhancers, data security programs, and a command interpreter that replaces the MS-DOS COMMAND.COM are all provided. What makes *The Norton Utilities* our favorite utility package is the fact that it doesn't consist of a single huge do-it-all program but rather relies on small (usually), specialized programs that perform no more than a few tasks each. You can use these little programs (which contain menus and directions) as individual entities or work through another program that steers you through the utilities themselves, offering useful advice.

For data recovery, which is prob-

ably still *Norton's* strongest point, eight programs let you diagnose, prevent, and fix almost any disk or data problem. Typically, several levels of recovery are offered: Depending on how much you're willing to help *Norton* along by supplying file names and other information (in some cases, the program won't be able to work without your help), you can recall erased files, repair corrupted data, or even restore whole disks that were formatted by accident. A program called Disk Tools (among other things) saves your computer's CMOS setup and your hard disk's partition tables to a floppy, letting you restore this information whenever you need it (a feature we consultants find extremely useful).

Data security, which is becoming more and more of a concern in corporate America as well as among individuals, is taken care of by programs called Diskreet and Wipeinfo, which encrypt your data or literally wipe it from your disk beyond the reach of all Unerase programs. Another security program, Disk Monitor, lets you know every time access to the disk or to a selected group of files is attempted (useful for virus protection).

Two of the three system-enhancement programs provided may not help much, depending on whether your setup is already optimal or not. Calibrate, a program that changes the way files are interleaved on your hard



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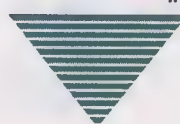
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disk and refreshes the disk's low-level formatting, won't work with all kinds of disks. (*Norton* itself determines by examining the disk whether Calibrate can work; IDE drives, for example, are out of the question, since they can't be low-level formatted.) Those drives it can be used on will benefit greatly, at least from the low-level formatting. (It's a good idea to run this routine regularly.)

Speed Disk, whose offered benefits are invisible until you have a major disk problem, makes sure that all your files occupy contiguous spaces on the disk (a process called

defragmentation), making data recovery much easier in times of crisis. This program might take as much as a few hours when run for the first time (depending on the level of entropy and size of your disk), but, if it's used daily, each session will take but a few minutes and will be worth the trouble someday.

Finally, Norton Cache, intended to improve disk performance, stores frequently used data in RAM, saving the computer the time it would normally use to read that same information from the disk repeatedly.

As always, *Norton* includes such

classics as System Information (more than you ever dared to ask about your own computer), Directory Sort (keep them files organized), Norton Change Directory (climb that directory tree up and down), Norton Control Center (change your screen colors, the cursor, the keyboard speed, and lots of other basic stuff), File Find (have you ever spent hours looking for a file?), Safe Format (fast and comprehensive diskette formatting), and many more. If you use computers on a regular basis, you'll have to look hard for an excuse not to buy *The Norton Utilities*.

The Norton Utilities v. 6.01: System requirements: 8086-based PC with 512K RAM; CGA, monochrome, or better monitor; MS-DOS 2.0 or higher; hard disk recommended. **Company:** Symantec Corporation, 10201 Torre Ave., Cupertino, CA 95014-2132, (800) 441-7234, (408) 252-3570.

The Hardware Doctor *(continued from page 14)*

day but not overnight. Here are our reasons:

Foremost, your computer is a mixture of moving parts (hard disk platters, disk drive spindles, cooling fan, the power switch, etc.) and non-moving parts (video adapters, hard disk controllers, etc.).

Of course, keeping a moving part moving when it's not needed generates heat, friction and general wear-and-tear. But moving parts suffer even more wear-and-tear when first started.

Non-moving parts can be damaged from the sudden power surge when your PC is turned on. A phenomenon known as the "electron wind" can cause metal ions on your circuit boards to move and eventually cause a short circuit between two connections on the board. The electron wind is generated by the burst of voltage when you turn your computer on. As computer components get smaller, with ever-smaller gaps between circuit lines, there is a greater chance of the

electron wind causing a problem.

Another danger comes from the changes in temperature your PC endures when starting and stopping. By turning your computer on, it moves from room temperature to its operating temperature. When turned off, the built-up residual heat can put some extra stress on the electronic components.

Generally, we recommend you turn off your computer if you will be gone for more than a half-day. This not only saves precious energy but also money. Some people even recommend that you turn the computer on once a day and off once a day—and no more. The same applies to your laser printer. For your monitor, its best to turn it down when gone more than an hour to prevent the screen's image from burning into the monitor's internal phosphor surface. For less than \$30, you can buy a screen blanker. Software screen blankers display attractive dancing images on

your screen to prevent such damage. Windows 3.1 includes some built-in screen blankers.

In the long run, whether you leave your computer on or off when absent, your computer probably will be obsolete before it burns out. ♦

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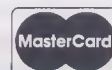
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by David Drucker

Q: I've been using computers long enough to have several dozen disks full of data created with CP/M programs. It would be useful to be able to use this data on my MS-DOS machine, but I haven't been able to find an economical means of converting it to the appropriate format. The data isn't valuable enough to make sending the disks to a conversion service worthwhile. Is there an alternative?

Robert Arneaux
St. Charles, Mo

A: You bet! If you're a member of CompuServe just join the CPM forum and download 22D137.EXE from Library 10. It's an MS-DOS program that reads from, writes to, and formats most CP/M diskettes. It's shareware, so if you use it and like it, you should send the author the \$25 registration fee. Alternatively, 22N132.EXE (in the same Library) can make your MS-DOS machine emulate CP/M. Either way, you should get the desired results.

Q: My 286 laptop has a 20Mb hard drive that's full-to-bursting. Is there any way to replace it with a larger one, or should I just bite the bullet and buy a new machine?

Anne McDonald
San Diego, CA

A: The answers to your questions are no and no. Actually, in the absolute, you might be able to have the hard disk in your machine replaced. It will depend on the machine, but in any event, the cost will be far greater than you're likely to be willing to spend. But if the machine is otherwise satisfactory, rather than replace it, why not just fool the hard disk into thinking that it's got more than 20Mb. There are two ways to do this, both involving data compression. If you need to carry lots of data files, but only

refer to one or two at a time, consider a simple compression utility that stores several files in a single "ZIP" or "ARC" file. They're available as shareware on virtually any bulletin board in the world, and depending on the nature of the files being compressed, can squeeze your data to anywhere from half to a quarter its original size. A bunch of Lotus 1-2-3 files that took up 290K on my hard drive now reside in a 92K ZIP file. It's worth noting that XTree Gold, that splendid file manager, incorporates PKZIP, along with an easy means of adding and extracting individual files as needed.

If you'd rather just have your 20Mb drive automatically, consider spending a few dollars on Stacker. It's an on-the-fly compression/expansion utility that—depending on the nature of your files—more-or-less doubles the apparent size of your hard drive. Once the program has been set up, it runs in the background, and is totally transparent. I've used the current version (Stacker 2.0, Stac Electronics, 5993 Avenida Encinas, Carlsbad, CA 92008, (800) 522-7822, \$149) for several months. It's been foolproof.

Q: It seems that every program I install wants to add its own subdirectory to my path. I remember reading somewhere that there's a limit to how long the path can be. Is this something I should be watching out for?

George H. Becker
Newport News, VA

A: Your question is a good one, since it gives me a forum in which to complain. The Path line has a 127 character limit, which should be plenty. In most instances, there's no need whatsoever for a program's subdirectory to be placed in the path. The primary purpose of doing so is to allow the user to run the program without first using a DOS command (CD [dir]) to change to that directory. I'm against any program modifying ei-

ther AUTOEXEC.BAT or CONFIG.SYS unless there's a good reason for it. Even then I'd rather see the install program offer the option of allowing the user to make the modifications himself or herself. (Symantec is particularly good about this, by the way.)

That being said, there's a way out, in the form of the DOS SUBST command. Here's how it works. If your AUTOEXEC.BAT file has a path that looks like this:

```
PATH C:\DOS5;C:\WP51;C:\LOTUS;  
C:\UTILITY
```

Substitute a drive letter for each subdirectory, adding a line for each into the AUTOEXEC.BAT file, and following them all with the path:

```
SUBST F: C:\DOS  
SUBST G: C:\WP51  
SUBST H: C:\LOTUS  
SUBST I: C:\UTILITY  
PATH F:\G\H\I\
```

Finally, you need to add a LASTDRIVE statement to your CONFIG.SYS file, since by default MS-DOS only knows about five drives, A through E. In this instance, the line would read:

```
LASTDRIVE=I
```

In our example, the path wasn't close to reaching the 127 character limit. But if you're getting up there, this solution will work very well. ☛

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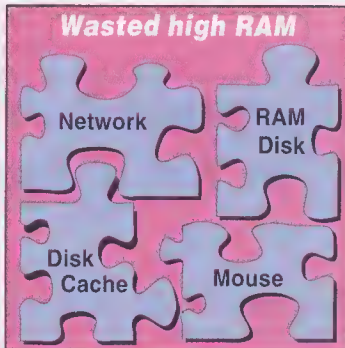
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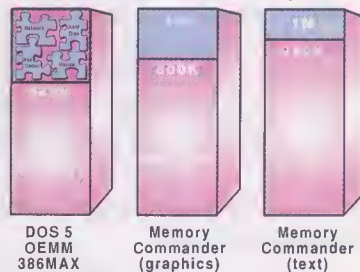
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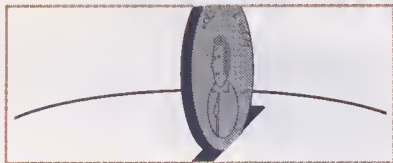
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Reusing Computer Supplies: Do Your Pocket Book—And The Environment—a Favor!

My jaw dropped to the floor when I calculated my computer costs for the 1991 tax season. Adding up all the consumables that go with owning and using a personal computer—data diskettes, ribbons, laser printer toner, and paper—I spent more than \$2,700!

Sure, some items are relatively expensive: about \$100 for a new laser printer toner cartridge. And each year I do go through a lot of supplies. But as much as I tried to rationalize the expenses, I realized that computer supplies were a serious drain on my personal finances.

Since I can't raise taxes to overcome my spending deficit, my only choice was to cut the fat. I just knew there had to be a way to stretch my computer supply budget. As it turned out, I found several relatively simple ways to save money—about \$500 per year.

And there's a bonus. Because all the methods described here involve reusing, there's less waste for the nation's landfills.

RECYCLE THOSE DISKETTES

For many computer users, diskettes are like rabbits. You may start out with just a few, but before long, you have diskettes bulging from every

cabinet in the office.

Surprisingly, not many of these mass-breeding diskettes are purchased by you. Instead, they come from software publishers, friends, associates, and who knows where else. For example, every time you upgrade your software, the publisher sends a new set of disks. If the software is complex (like *Windows* or *WordPerfect*), one upgrade can add five or ten disks to the pile. Do this often enough, over a period of time, and you may end up with hundreds of surplus diskettes.

It's rather obvious to reuse diskettes. Just erase the old data and record the new data. But it's not always that simple.

First, there's the issue of old labels. Unless the recycled diskettes are for your own use, you may not feel comfortable sticking your label over the old one. Just peel off the old label, you say? Try it. Most diskette labels are permanent. If they come off at all, they leave a sticky residue that's much worse than what you had before.

You can usually remove diskette labels with "sticker remover," available at most variety stores. I've tried different brands. So far, all are "friendly" to the plastic used in the

jacket of the diskette. Still, you should try a dab to be sure that the solvent in the sticker remover doesn't also remove the outer covering of the diskette.

Second, there's the issue of read-only diskettes. With the 5.25-inch diskettes, a notch is cut into the diskette jacket to allow the disk drive in your computer to write new data, as well as read existing data. Cover up the notch, using write protect tabs provided with the package of diskettes, and the diskette is read-only. Read-only disks mean just that: Erasing the diskette, or recording over it, isn't allowed.

The system is slightly different with 3.5-inch diskettes. With these, a small hole is punched through the upper-right corner of the disk. Inside the hole is a plastic tab, which slides along a rectangular channel. To enable the disk to both read and write data, a plastic tab is moved so that the hole is blocked. Move the tab back—the hole is uncovered—and the diskette is read-only.

Where does all this lead us? Some software publishers distribute their programs on permanent write-protected diskettes. If the diskette is the 5.25-inch variety, there's no notch in the jacket, so there's no way you can

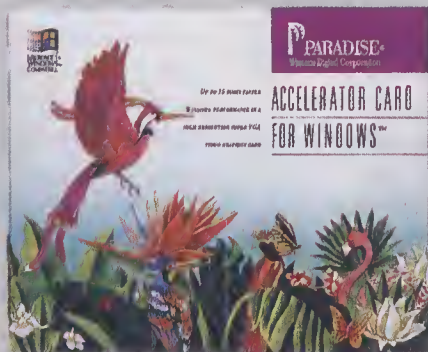
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get your computer to use the disk for new data. If the diskette is the 3.5-inch type, no slide is provided to cover up the hole.

Still, there are ways to get around this limitation so you can reuse these write-protected diskettes. If you use 5.25-inch disks, invest in a diskette notcher. It costs about \$10. The tool cuts a notch in the diskette at the proper location. You can also use a pair of scissors or a sharp knife, but a diskette notcher is the more reliable (and safer) method.

If you use 3.5-inch floppies, put the black or silver write protect tab normally used with 5.25-inch diskettes over the front of the hole. Make sure the tape is on securely, and doesn't wrap around the side of the diskette. Otherwise, the tape may come off in the drive, and possibly cause mechanical damage.

When reusing diskettes, it's a good idea to completely reformat them. This process ensures that you don't use a bad diskette.

RE-INKING RIBBONS

If you own daisywheel or dot matrix printers, you can shave a few dollars off your annual supply budget by re-inking ribbons. The process is relatively easy, although you do need a special re-inker jig to do the job. Re-inkers are commonly available through mail order. (Check recent issues for ads.) The re-inker from Computer Friends is one of the better made units, although it does cost a bit more than the others. Most re-inking jigs are made for a particular type of ribbon, so be sure to get the right model.

To re-ink a ribbon, merely put the ribbon on the jig, and apply the ink from a bottle. If the jig is manually operated, you need to turn a crank to move the ribbon by the re-inking rollers. Turn slowly. The more expensive jigs are motorized; just flip a

switch and stand back.

Depending on the dryness of the ribbon, and the design of the re-inker, you may need to repeat the process one or more times to ensure that the ink is evenly distributed. Don't apply too much ink, however, or you'll end up with an indelible mess.

Printer ribbons do get old with use. You should avoid re-inking tired and frayed ribbons. A good rule of thumb: Limit your ribbons to three re-inkings. After the third time through the re-inker, throw the ribbon away. You should also visually inspect the ribbon prior to re-inking. A frayed ribbon can seriously damage a dot matrix printer. If the ribbon looks tired and worn out, throw it away.

REFILLING TONER CARTRIDGES

Laser printers are the rage today. Unlike dot matrix and daisywheel printers, the lasers don't use ribbons, but a cartridge or reservoir filled with extremely fine black powder. This powder is called toner, because it makes the image on the printed page.

The most popular laser printer for personal computer use is the Hewlett-Packard LaserJet. It, like other printers based on mechanisms built by Canon in Japan, uses a cartridge that contains other consumable items as well, such as a photoreceptive drum and a magnetic "developer" bar. All three items need to be replaced after three or four thousand pages. Rather than replacing them as separate units, they are replaced as a whole by merely removing the old cartridge, and inserting the new one.

The cartridge must be replaced if the toner is exhausted, but the other components in the cartridge may still have some life left in them. Therefore, it makes sense to merely fill the cartridge with new toner, and put the old cartridge back into the printer.

This is the idea behind recycling laser printer toner cartridges. Use the cartridge, and when the toner is gone, recharge it with more of the black powder.

You can recycle toner cartridges yourself, although you may prefer to have a company specializing in the process do the job for you. There are dozens of mail order outfits who accept used cartridges, and in return send you a refilled one. Some do a more complete job than others, so shop for the best service. On average, you save 40 to 60 percent by refilling your old toner cartridge, rather than replacing it with a new one.

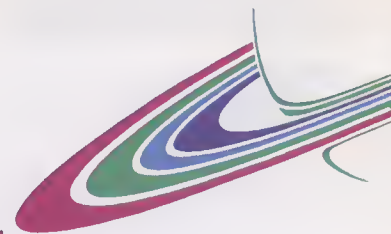
USE THE BACK SIDE OF PAPER

If you have a laser printer, you can save on paper by reusing the scrap pages (you know, pages that come out blank, or with the wrong printing). Obviously, this is appropriate only for draft copies of the documents you create.

Merely collate the scrap pages, making sure that the used side is face down. For the best results, place the used paper under a heavy weight, such as an oversized encyclopedia. This helps reduce the curl so that the used paper will feed through your laser printer with minimum jamming.

While printing with once-used paper is a great way to save on printing drafts of documents, it can have a harmful effect on your printer. The reason: Toner from the back side of the paper may come off the page, and fuse with the pressure rollers inside the printer.

On the Hewlett-Packard LaserJet printers, for example, the bottom pressure roller isn't designed for an accumulation of old toner. This roller can be damaged if it accumulates too much toner. This caveat doesn't apply if your printer is designed for two-sided (duplex) printing. ■



HARD DISK UPGRADES— NOW \$200 LESS EXPENSIVE!!

Sooner than later you will experience the frustration of running short of disk storage space. Additionally, program upgrades, although more efficient in operation, also require more and more storage space. The Complete Portable can replace your existing hard disk with a compatible, higher-capacity drive to give you more storage capacity and faster access times.

More Storage for 286, SX and 386 Portables!

Portable computers based on 80286, or any of the 80386 family of microprocessors, still have years of potential use—only disk size and disk speed limits that potential. The Complete Portable performs disk upgrades from 40 to 170 megabytes of storage. With certain AC-powered portable computers, such as Toshiba's 3100/3200 and 5100/5200 series, disks can be upgraded to 210 or 520 megabytes.

Faster Access to Information!

Older generation disk drives can be 10 times slower than newer hard drives. Faster disk drives even serve to eliminate troublesome problems that occur with advanced software such as Microsoft Windows 3.0.

All Software Re-installed!

The Complete Portable saves all your software (which is not copy-protected) and data on tape prior to the upgrade. Then we reload it to your new, higher capacity disk drive. You receive your computer ready to go!

Anti-virus Sweep!

To protect the integrity of your new system, The Complete Portable performs an anti-virus sweep of your system when it comes in. We then notify you if your old disk drive was exposed to a virus and let you know how to avoid them in the future.

The Best Drives in the Business!

Conner Peripherals, Inc., one of the best suppliers of 2.5" hard disk drives for notebook computers and 3.5" hard drives for portable computer systems, is the main supplier of our hard drives. Conner Peripherals disk drives are not only fast and durable, they are also designed to withstand the shock, bumps, and bruises which portable computers are commonly subjected to in transit.

Full One-year Warranty!

All disk drives, installed by The Complete Portable, are factory new and protected with a one year warranty on parts and labor.

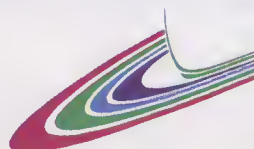
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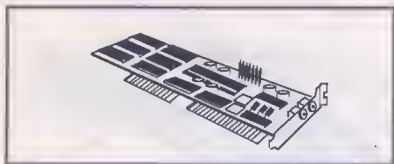
When The Complete Portable receives your order for a disk upgrade, we send you an empty box and instructions for packing and shipping your notebook or portable computer to use for the upgrade. We even arrange the U.P.S. pick-up of your system—freight and insurance pre-paid! Within another week, your system will be back in your hands with its larger and faster hard drive, software reinstalled, and ready to go!

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520M*	HDP-0520	\$1499
Freight & Insurance		\$15
Disk Cache	SFT-0008	\$99

NOTEBOOK COMPUTER (2.5" HARD DISK)		
40M	HDN-0040	\$499
60M	HDN-0060	\$599
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Disk Cache	SFT-0008	\$99
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Analyze and Fix Your Own PC With This Easy-To-Use Power-On-Self-Test Card

Well, you've had your computer for over a year now. It's made a difference in your life. Somehow, you can't understand how you ever got along without it, but unbeknownst to you, you're soon going to find out. As you turn your computer on, you wait for the myriad of messages to flash by as it goes through the boot-up process. But wait, nothing's happening. The screen is totally dark. Maybe you forgot to turn the video monitor on. No, the little green light that shows you it's on is lit. Then you start to think, "Did I load any new programs on my computer that might have contained a virus?" You know the answer even before you finish forming the question in your mind. No, you didn't.

A bead of sweat forms on your forehead now as you try to figure out why your computer won't work. Maybe the video cable came loose. You must have knocked it loose by accident. As you reach around towards the back of the computer, your brief moment of relief ends. The video cable is snugly attached; your screen is still black. In frantic desperation you start grasping at straws. "Maybe it just had a problem booting up this time. I'll shut it off and turn it on again." You do and nothing changes. You still have this black screen staring back at you. Also, now that you're more attuned to the problem, you realize that your hard disk isn't turning on like it usually does, and neither is the floppy disk drive. Even the lights on your keyboard

don't flash like they usually do when the computer boots up.

Finally, grim reality starts to set in. The unthinkable has happened. Your computer has died! Returning from a state of near panic, you start to assess the damage and figure out what your options are. Thank goodness you back up your data, you think. Data is stored on a removable Bernoulli disk. But how are you going to read it? Did the crash that killed your computer take the hard disk with it? You'll only find out once you get the computer up and running again.

What Are Your Options?

Once a computer dies, you usually have three options available to you:

1. You can use it as an excuse to go out and buy another, more advanced computer that you probably can't afford.
2. You can get the motherboard replaced and hope that solves the problem.
3. You can take the computer to a technician who will analyze it and fix the broken part.

Evaluating the options is easy. If you have the money and were going to get a new machine anyway, there's no decision. It's already been made for you. But if you can't afford a new computer, then you have to look for a cheaper solution. That brings us to option two. This is probably the one that most people will eventually wind up going with, because most of the time option three leads here, too.

Your computer can almost always be resurrected if you perform a motherboard transplant. The biggest problem you'll face is cost, which can run you anywhere from \$300 to \$800, depending on what the processor in your computer is or, more correctly, what processor you want on the replacement motherboard.

If money is no object and you don't want to try and fix your computer yourself, option three is the way to go. But if spending the fewest dollars possible and having your computer fixed is your goal, there is a fourth solution. It's called POST Cards. The one we look at this month is Post-Probe from Micro 2000, Inc. Post-Probe is a universal diagnostic card that simply plugs into any empty slot in your computer and helps you find out what's wrong. It even works on brain-dead computers like the one just described. In fact, it was specially designed to tackle that problem. We know it works, because we tried it out on a dead system in our office, found out what was wrong and got the system up and running.

The board gets its name from the operation most computers go through as they boot up. It's called Power On Self Test (POST). Most computers run through this sequence and produce a variety of test signals that can be monitored to determine where a problem has occurred. Unfortunately, most PCs and XTs don't have a power-on self test feature. Also, computers that use the DTK BIOS, also lack this feature. Even in computers without

built-in POST capability, this board can be used to diagnose the system.

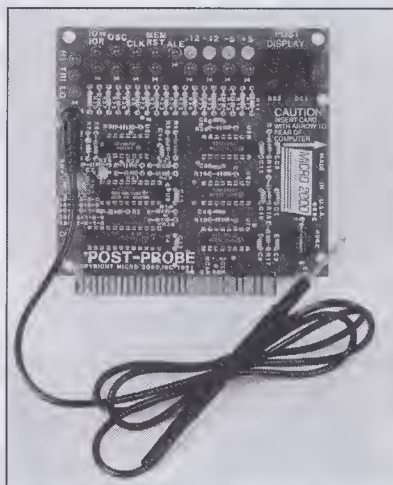
While the board looks simple in its design, it can display all the signals you'll need to check to diagnose your system's problems. If you're not a technical wizard, don't despair. Using the board is very easy. The manual that comes with it is detailed and the Troubleshooting Techniques Section gives you step-by-step instructions. Finally, if all else fails, call the technical support line. Getting through isn't difficult, and we found Micro 2000's tech support staff very knowledgeable and helpful.

Installation

Installing the board is easy. Just turn off your computer, plug the board into an empty slot, and then turn the computer back on. Before you turn the computer back on, however, plug in the logic probe that comes with the card. You'll find it useful later. By the way, you should know that the Post-Probe card can be used in either ISA and EISA computers or MicroChannel-based computers such as IBM's PS/2 Series. To use the card in a MicroChannel machine, it's first plugged into a MicroChannel adapter, which is then plugged into the computer.

Once you turn the computer back on, the card will monitor all critical signals in the system and display them for you. The first thing that the manual tells you to do when a computer won't boot, is to look at the card and see if the correct power is being applied to the system's motherboard. This can be done by looking at the four voltage LEDs on the Post-Probe. They monitor the four dc voltages on the motherboard: +/- 12 volts and +/- 5 volts. These LEDs should come on as soon as the computer is turned on and remain solidly lit without wavering in intensity. If this doesn't

happen, then either the power supply is bad or there's a short circuit on the motherboard that's draining the power before it reaches the expansion bus. If one of the LEDs doesn't light,



Micro 2000's Post-Probe.
How it works: a POST card intercepts the diagnostic code being sent to a particular electronic address and displays it on LEDs or a two-digit display.

the power supply is definitely the problem.

In our case, the power supply was okay, so on to the next possibility. If the voltages are okay, the next thing to look at is the system clock because this is what makes the system "tick." Two LEDs are used to display this signal. They should blink alternately. If they do, all is well with the clock. If one LED lights and the other doesn't, the clock generator chip is suspect. If neither lights, it could be the clock chip or the oscillator crystal. Our system clock was fine.

The next possible culprit is the system oscillator which in PCs and XT's was used for all system timing, but in AT's and later is only used for the color frequency which is needed by the video controller card. If these two LEDs don't light up in an alternating fashion, the oscillator's 14 MHz crystal is probably bad.

Another LED to check is the Address Latch Enable (ALE) LED. This latch is a function of the CPU. If it doesn't work properly, the LED won't come on and the CPU, DMA, bus controller, or clock generator are the main suspects. This too, was okay.

The I/O Write and I/O Read LEDs were checked next. These didn't light as they're supposed to. Their failure indicates that there's a problem with either the BIOS or the DMAs.

The BIOS Did It

Finally, the digit alphanumeric display that displays the POST code was checked. It displayed FF. The manual tells us that the BIOS either doesn't emit POST codes or is defective. Since we know the BIOS does emit POST codes when it's operating properly, the only alternative possibility is a defective BIOS. Just to confirm the diagnosis, a call was made to the technical support line. It was confirmed. The technician we spoke to told us to try and get a BIOS from the same company that produced it originally or we would also have to replace the keyboard controller. That's what we ended up doing.

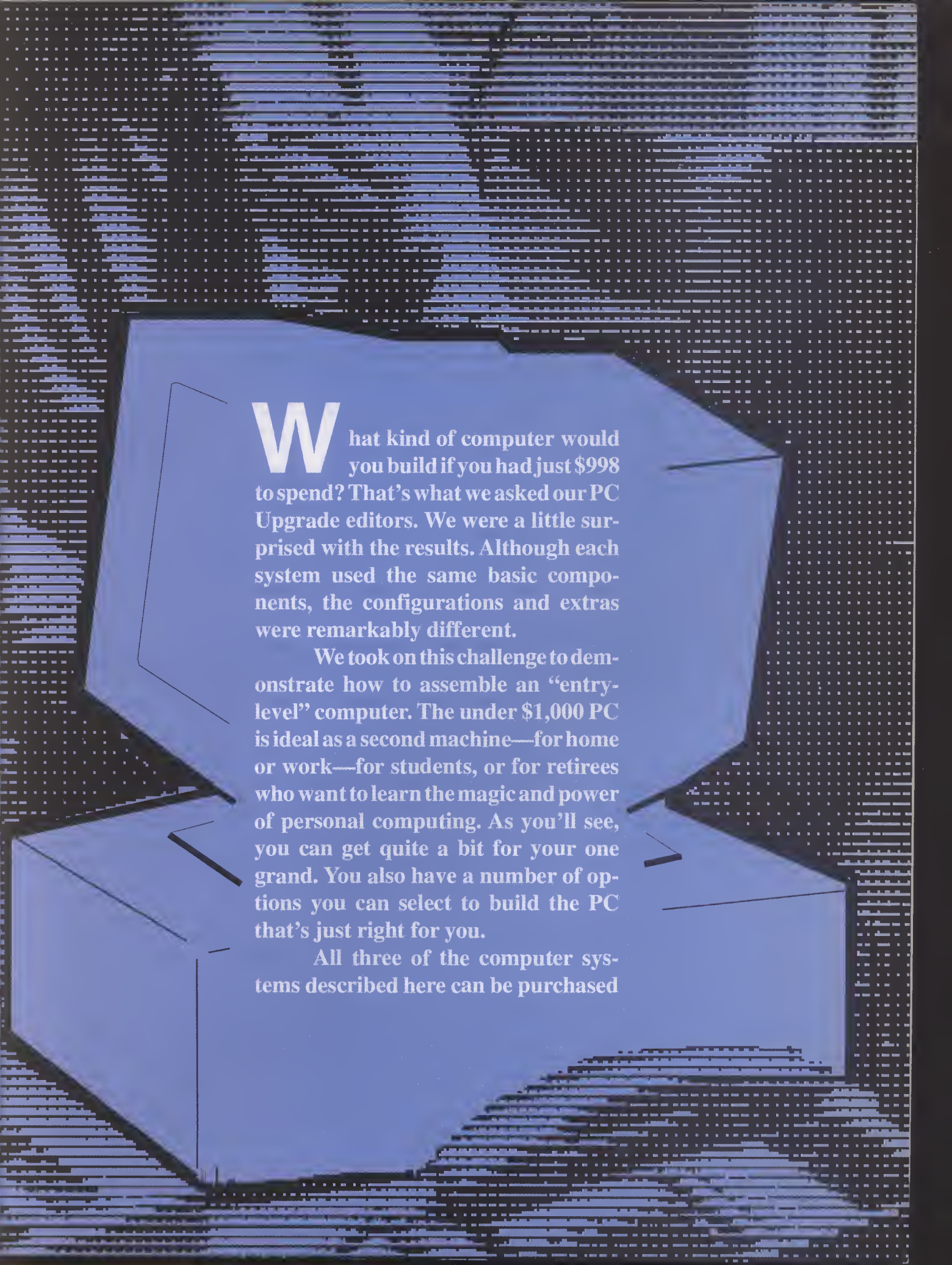
While it wasn't necessary to check other signals monitored by the card, there were more we could have used, as well as the card's built-in Logic probe.

We found the Post-Probe to be everything it was cracked up to be. The manual was well prepared, with an excellent explanation of the full power-up self test process and a step-by-step testing guide. We would have liked to have seen an index in the manual so we could find things a little more easily. ■

Price: \$399. **Company:** Micro 2000, Inc., 1100 E. Broadway-3rd Floor, Glendale, CA 91205, (818) 547-0125.

\$9998

**What You Can
Build —
And How**



What kind of computer would you build if you had just \$998 to spend? That's what we asked our PC Upgrade editors. We were a little surprised with the results. Although each system used the same basic components, the configurations and extras were remarkably different.

We took on this challenge to demonstrate how to assemble an "entry-level" computer. The under \$1,000 PC is ideal as a second machine—for home or work—for students, or for retirees who want to learn the magic and power of personal computing. As you'll see, you can get quite a bit for your one grand. You also have a number of options you can select to build the PC that's just right for you.

All three of the computer systems described here can be purchased

for \$998 or less, excluding local tax and shipping charges. The prices given are typical of mail order; you may spend more or less, depending on the vendor.

Of course, there's no rule that says you must stick with the under \$998 pricetag for your own system. You can spend as much or as little as you want. We used the under-\$1,000 price to make a point: You can assemble a workhorse PC for relatively few dollars, and have many ways of doing it.

Feel free to mix and match the systems presented below, and substitute components as you see fit. The idea of building your own system is that you can choose exactly what parts it will have. If you don't want a telephone modem in your computer, for example, don't add it. Instead, you can spend your money on something else, like more random access memory (RAM), a larger hard drive, or a second floppy disk drive.

All three PCs are "complete" computers, and are ready to go. Complete is in the eye of the beholder, of course, but all three of the computers have at least the following basic components:

- Case
- Main board (motherboard)
- Power supply
- At least one megabyte of RAM
- ROM BIOS for motherboard
- Keyboard
- One 5.25- or 3.5-inch disk drive
- Hard disk drive (minimum 40Mb)
 - Controller for floppy and hard drives
 - At least one parallel and serial port
 - Display adapter
 - Monitor
 - Keyboard

All three \$998 computers are built on the same framework: case, motherboard, and power supply.

Within this "bare bones" system goes the hard and floppy drives, display adapter, etc.

Assembly

In many instances, you can purchase the basic system already assembled for you. That saves you some steps, without costing a great deal more money. For example, the typical prices for an 80386-based PC, with 200 watt power supply, case, and a megabyte of memory already installed, is about \$300.

To finish building this system, you merely install the floppy and hard disk drives, as well as the add-in cards—floppy/hard drive controller, monitor, serial/parallel port, etc.

But suppose you purchase the basic parts separately. You'll need to put the pieces together. Don't worry: The job really isn't that hard. Here are the steps:

Step 1. Install the motherboard inside the case. The case should come with the necessary hardware for attaching the motherboard. This hardware will either be metal screws and plastic spacers, or plastic "stand-offs" that snap the motherboard in place within the case.

Step 2. Connect the switches and indicators on the case. Depending on the design of the case, you'll need to hook up the Reset, Turbo, and Power buttons to control your computer. Indicator lights or read-outs are often used to display the current state of the computer. Refer to the manuals that came with the case and motherboard, and connect these as well. All hook-ups are through connectors, most of which are polarized so you don't run the risk of installing them backwards. However, you should still be careful to orient the connector properly, or damage could result.

Step 3. Connect the case speaker to the motherboard. One final connection you'll want to make is connecting the speaker, which is mounted on the case, to the motherboard. Like before, you merely plug the connector at the end of the speaker wire to the proper location on the motherboard. Orientation rarely matters, so it doesn't matter if you attach the connector backwards.

Step 4. Install the power supply. Your PC needs a power supply to convert household current to the direct current needed by the computer's electronics. The power supply is attached to the case using four screws.

Step 5. Connect power supply leads to the motherboard. Two of the cable harnesses coming from the power supply attach to the motherboard. These are often labeled P8 and P9. Attach these power cables to the motherboard, according to the instructions provided with the power supply (and/or motherboard). Orientation is critical! And be sure that you don't swap the positions of the two cables. If you do, the motherboard will be permanently damaged.

Step 6. Add RAM to the motherboard, as necessary. If the motherboard doesn't already come with RAM, you'll want to add it now. Most PC motherboards use single in-line memory modules (SIMMs) that merely plug into corresponding sockets on the motherboard. Some 80386-class motherboards use a variant of the SIMM called the SIPP, for single in-line pin package. These are a little harder to install, because you must carefully align the pins at the base of the SIPP into their socket holes. And finally, a few 80386-class motherboards still use DIP memory—memory chips in discrete 16 or 18 pin integrated circuits. These are the toughest to install; for best results, use a DIP chip installer tool, available at Radio Shack. See the article

Don't Forget The Memory in this issue for more details about RAM and how to install it.

The basic system is now finished, but the computer isn't complete yet. Other required items that must be installed inside the computer are a floppy drive, a hard drive, a controller card for the drives, and a display adapter for a monitor.

Installing A Hard Disk Drive

Hard drives are typically installed in either of two places: in one of the drive bays usually reserved for a floppy drive, or inside the case in a special compartment made just for a hard disk drive.

The design of all cases allows you to install the hard drive in a drive bay. The number of bays differs from one case to another. "Mini" cases have two or three bays, which can accommodate that number of disk drives. Larger cases have up to five or six bays. These are ideal if you plan on adding lots of disk drives to your PC.

If you plan on installing a hard drive into a drive bay, you should use the mounting rails that came with the case. These rails are standardized, and should fit almost any hard drive you wish to install. Using a screwdriver, secure the rails to the drive, then simply slip the drive into the bay. The rails lock into place.

To save drive bay space, you may elect to install the hard drive inside the case. Not all cases have room for internally mounting a hard drive, but many do. The hard drive compartment fits only 3.5-inch hard disk drives, either full or half-height. (The height of a drive is arbitrary; full-height is normal, and half-height is a slimmer version.)

Install the hard disk in the drive compartment using the hardware supplied with the case.

With the hard drive physically installed, it must be electrically connected to the motherboard and the power supply. Attach one of the disk drive cables from the power supply to the power connector on the back of the drive. The cable will attach one way only.

Next, attach the data cable between the drive and the motherboard. Some motherboards are already equipped with the interface electronics to support a hard drive. If so, then just plug the data cable between the hard drive and the appropriate socket on the motherboard. Otherwise, you'll need to first install a hard drive controller card to an empty slot on the motherboard. For convenience, use a slot close to the hard drive and power supply.

Installing A Floppy Disk Drive

Floppy disk drives require external access, so they can be installed only in a drive bay. Like a hard disk drive, you use the mounting rails that come with the case to install the floppy drive into a bay.

Before sliding the drive into place, however, make sure its DIP switches and jumpers are set properly. The task is relatively easy if you install just one floppy drive, since the default settings place the floppy disk drive as drive A.

If you're installing two floppy drives, however, you'll need to set one to drive A, and the other to drive B. Unfortunately, the instructions that come with most floppy drives are sketchy at best. You're left with a great deal of trial and error to find the proper settings. The setup configuration for each make and model of floppy drive is different, so you can't count on generic "this should work" instructions. You may be better off having your dealer preset the drive

for you, just to save you the trouble.

To complete the floppy drive installation, install the floppy drive controller card in an unused slot on the motherboard. (Note: Some motherboards integrate the controller card on-board, so you don't need a separate expansion card. Some controllers combine functions for hard drive and floppy drive). Attach the data cable between the back of the drive and the controller card. Be absolutely certain of the orientation. Not all drives and controller cards use "keyed" connectors so it's possible to insert the cable backwards. Doing so may erase or damage the disks you insert into the drive! If there's no notch or key, you can rely on the color code method: Line up the red (sometimes blue) strip with pin 1 on the drive/controller.

Repeat the process if you're installing a second floppy drive.

Finishing The Installation

Only a few parts remain and your computer is finished. You need some way to see what the computer is doing, so you must install a display adapter and monitor. Attach the display adapter card in an unused slot on your PC's motherboard. (Set the DIP switches or jumpers ahead of time, as detailed in the manual that accompanies the display card.)

Plug in the keyboard, monitor cable, and power cable to your computer. Take a few moments to inspect your work, then plug the power cord into the wall. Turn on the monitor, then flip the power switch on the computer to on. Assuming everything is installed correctly, the computer should come to life.

If a problem does occur, the computer will usually tell you by displaying an error message on the monitor, and/or by beeping the speaker one or

more times. The exact error message and "beep sequence" differs depending on the BIOS chip installed on the motherboard of your PC, so you should refer to the manual that came with the motherboard for specifics.

Ways To Upgrade

From the three systems, you can readily see that a good, basic PC doesn't have to break the bank. You can use the PCs presented here as examples for building your own entry-level systems, or as springboards for enhanced configurations.

Perhaps the most effective upgrade you can make is to add more memory. Most 80386-class and higher motherboards now accept memory up to 16Mb on board. Memory prices are low—about \$40 to \$50 per megabyte, depending on the source. (Our prices depict a good average; you can often find memory for as low as \$30 per megabyte.) Today, it's not unusual to construct a system with eight, 12, or even 16Mb of RAM, especially if you plan on using Microsoft *Windows* or OS/2 2.0.

System 1 includes a tape backup drive, a handy gadget to have on any system. For less than \$200, you can protect yourself against costly data loss in case something should happen to your hard disk drive. It's cheap insurance. In addition, the tape drive makes backing up a breeze.

We designed three "typical" under-\$1,000 systems, listed in the sidebar at the right. All were built the same way, but use many different components.

Depending on your needs, you may also want to add such items as a mouse or trackball, an internal modem or fax card, a one megabyte super VGA display and VGA monitor, or a tower case. If you shop wisely, these extras shouldn't put you far over the \$998 mark. ■

Our Three Sample Systems

Here's how it all stacked up:

System 1:		
Item	Specifications	Price
Motherboard	80386SX-16	\$145
Memory	1Mb	\$52
Drive controller	Floppy drive	\$18
Floppy disk drive	5.25" 1.2Mb	\$57
Hard drive	42Mb (w/controller)	\$209
Display adapter	Mono graphics	\$23
Monitor	12" mono	\$82
Case	"Baby" AT desktop	\$35
Power supply	200 watts	\$42
Keyboard	101 keys	\$37
Extras	120Mb tape backup 80387 math co-processor	\$199 \$99
Total		\$998

System 2:		
Item	Specifications	Price
Motherboard	80386SX-25	\$179
Memory	2Mb	\$104
Drive controller	Integrated	—
Floppy disk drive	Dual 5.25" & 3.5"	\$119
Hard drive	64Mb (w/controller)	\$215
Display adapter	VGA. 256K	\$39
Monitor	VGA color	\$222
Case	"Baby" AT desktop	\$35
Power supply	250 watts	\$42
Keyboard	101 keys	\$37
Total		\$992

System 3:		
Item	Specifications	Price
Motherboard	80386-33	\$249
Memory	4Mb	\$169
Drive controller	Integrated	—
Floppy disk drive	3.5" 1.44Mb	\$57
Hard drive	64Mb	\$215
Display adapter	VGA, 512K	\$55
Monitor	14" VGA mono	\$114
Case	Standard AT desktop	\$42
Power supply	250 watts	\$42
Keyboard	101 keys	\$37
Total		\$980

All three systems are 80386-based, although only one uses the full 80386DX chip; the other two use the less expensive 80386SX chip. By using an 80386SX motherboard, there's money for some extras.

In System 1, for instance, the low cost of the 80386SX-16 (16-MHz) motherboard leaves extra room for a 120Mb tape backup, and an 80387 math co-processor. System 2 uses the cost savings to invest in a color VGA display card and monitor. Note that System 3, which uses a 33MHz 80386DX motherboard, uses a 14-inch "paper-white" monochrome monitor, instead of a color monitor.

System 2 uses an interesting component: a dual floppy disk, consisting of both a 5.25- and 3.5-inch drives. These dual drives are relatively new, but they save space, and are now available for about the same price as two separate floppy drives. One benefit of the dual drive: You don't have to worry as much about setting DIP switches or jumpers to configure the drives. The drives come pre-set at the factory. You only need to change the defaults if you want to. □

(continued from page 6)

SCSI Mysteries The drive in place, I now had a little trouble. The chain of SCSI devices attached to my Mac had always worked fine (two items connected to the SCSI port, plus the main hard disk), but when I went to boot from the new drive the process stalled; I reckoned this was related to SCSI termination, a subject about which lengthy articles have been written. Maybe books for all I know. The theory is that there should be terminating resistors, or terminators, on the devices at either end of the chain. The Mac's internal hard disk comes already terminated. And the last device, in my case a nice removable-cartridge drive from CMS, should have a terminator plugged into one of its SCSI ports. That is the theory. In practice, I had been running it for months without termination; it preferred it that way.

But as I say, the new hard disk wasn't booting. Maybe something about it was influencing the electrical load on the chain. For the hell of it I stuck a terminator into the port on my CMS drive and sure enough the system booted properly. Maybe the engineer who invented SCSI could explain what had happened; I certainly can't. The point is that with chains of Macintosh SCSI devices you cannot go by the book (unless going by the book just happens to work for you). So if you install a new hard disk—or any other SCSI device from a scanner to a gigabyte external optical drive—and your system won't start, try fiddling around with terminators.

In fact, what you should try first is to disconnect all external SCSI devices, then reconnect them one at a time, in an attempt isolate the problem. Any of these changes should be made with the computer turned off, by the way. Dire warnings are issued to those who alter the SCSI chain

with the power on—though I can report from experience that these warnings are a little extreme: I have, through forgetfulness, connected and disconnected external drives with the computer power on (but with the drive power off) with no grievous effects other than mild anxiety.

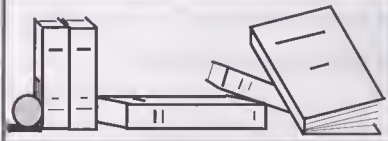
There really isn't much more to report on this subject. My new drive is in, and it works. It is indeed faster than my old one; start-up is speedier owing to quicker access to INITs and CDEVs; time has also been noticeably shaved from opening big programs like PageMaker and FreeHand. And having an additional two hundred megabytes of elbow room means I can expand all the secondary applications and data I had compressed

(using *StuffIt*) to save disk space.

Moreover, I always promise myself I'm going to learn how to work with Adobe PhotoShop; now I don't need to worry where I am going to store the multi-megabyte color photo files I'll soon be retouching. I just need to worry where I'm going to get them in the first place, as my antiquated 8-bit grayscale scanner is certainly not going to be any help. Maybe that is a new area for upgrading!

Storage Dimensions, Inc.

1656 McCarthy Blvd.
Milpitas, CA 95035
(408) 954-0710
325Mb Internal drive: \$2,059.00



BOOKS

by David A. Finck

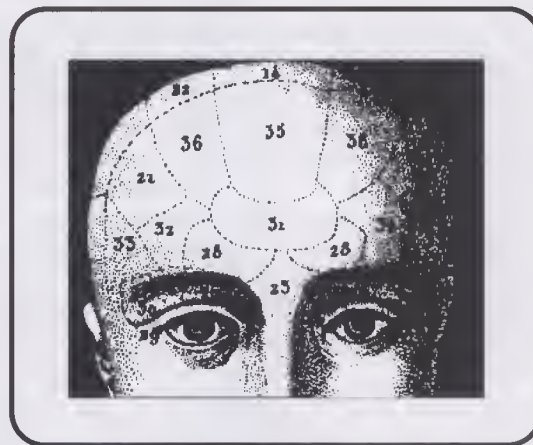
BUILDING YOUR OWN

Readers of this magazine will be interested in *PCs From Scratch; Designing and Assembling Your Own Custom PC* by Corey Sandler, Tom Badgett, and Wade Stallings. First published in 1990, it's a bit behind the times (the mention of 486 technology is one 6-line paragraph) without being dated. There's a lot of valuable basic information here that makes it still worth reading today.

Targeting both beginners and experienced users, the authors give detailed descriptions of every component of your PC, covering power supply, motherboard, controller drives, and co-processors. Input devices including keyboard, mouse, scanners, and modems are discussed, and there is a lengthy section on video graphics and monitors. The book offers explanations not just of what these components do, but of how they do it as well. Clock cycles, access time, execution time, interrupt processing, the mechanics of hard drives, controller technologies, and much more are covered. Finally, an assembly tutorial instructs how to put all these parts together into a useable system, how to test it, and what to check if it doesn't work right away.

From Bantam books, it's just been re-issued and is available at bookstores, \$22.95. It's probably available at the library, too. □

DON'T FORGET THE MEMORY!



Is your system starving for more memory? Let our expert explain how to find out if you have a problem and how to fix it.

Ask any old-timer about the “good old days”—circa 1982 or so—when personal computers were still exotic curios. They’ll fondly remember when 64K of memory was considered a treasure trove.

The “K” doesn’t stand for gold karats, but computer memory is almost as precious. Here, K means kilo, or one thousand (in computer terms, K really means 1024, but let’s forget about that for the time being). There was a time when 64,000 bytes of RAM was considered more than enough for almost any application.

Slowly, but surely, the need for more random access memory (RAM) increased. By 1990, the average program designed for Microsoft’s MS-DOS operating system required 512K of RAM. Now, with Microsoft Win-

dows, your computer is useless if it doesn’t have memory in the megabytes—millions of bytes of RAM.

Let’s take a look at memory and what it does for your computer, whether it’s a desktop or laptop model. And while we’re at it, let’s examine memory used for printers, too, since the latest models use lots of RAM to support high resolution graphics and fonts.

What RAM Does

RAM is an electronic holding tank, a place that stores your programs and data while you’re using your computer. This holding tank is temporary; when you turn your computer off, the data in RAM is erased. For long-term storage, programs and data are recorded onto floppy disks, or

onto the metallic surface of a hard disk drive.

The amount of RAM in a computer determines its ability to juggle large amounts of data simultaneously. The more RAM, the more information that can be contained in your PC at once. This makes your computer better able to crunch large amounts of numbers or manage large word processing documents.

Because of the way computer software is written, it requires a minimum amount of RAM just to load the program so you can begin to use it. As new features are added to software, the minimum requirement for RAM increases. It’s unusual to see a DOS-based business-level word processing program, for example, require less than 384K of RAM. (One byte holds about one character, so if a

document contains 35,000 characters, it needs about 35K of RAM to store it.)

Usually, the minimum requirement of RAM is just that: You can't use the program with less RAM, but the more RAM you have, the better the program runs.

This maxim is particularly true of Microsoft *Windows*, and programs designed to run under *Windows*. For computers equipped with an 80386 microprocessor (the most popular), *Windows* requires no less than two megabytes of RAM to operate. That's 30 times more than the 64K considered "more than enough" when the IBM PC was first unveiled in 1981.

But, two megabytes of RAM really doesn't get you much. *Windows* runs considerably faster with four, and even eight megabytes. A number of popular *Windows* applications, such as Microsoft *Word*, *WordPerfect for Windows*, and Microsoft *Excel*, need a minimum of four megabytes to operate smoothly. Many users of these and other *Windows* programs have reported substantial improvements in speed when they add even more RAM to their PCs.

Also RAM-happy is IBM's latest version of their OS/2 operating system. The minimum RAM requirement to use OS/2 2.0 is eight megabytes. Serious OS/2 users have increased the memory in their PCs to 12 and 16 megabytes—amounts unheard of just a few years ago.

Do You Need More RAM?

Of course, the amount of memory you need in your computer is dependent on the programs you run. If you aren't using *Windows*, there's little use in adding megabytes to your PC, because most DOS applications really won't use the extra memory. (Some do, some don't; check the software manual to be sure.)

If you're attentive, and learn the warning signs, you'll know if you need more RAM in your PC. Watch out for the following:

1. Programs load and run much slower than they used to. Is the latest version of *WordPerfect* for DOS noticeably slower than the previous version? They added many new features. These extra features need more memory to run.

2. Your software accesses your computer's hard disk more than it used to. Most modern PC programs use a portion of hard disk space for temporary memory storage. Increased hard disk use when you're not saving or retrieving a file could indicate that your programs are starving for RAM.

3. The latest versions of programs refuse to run. Added features add to the weight of a computer program, and require more RAM to operate. Just because the old version ran on your machine is no guarantee than the latest one will.

Adding More RAM

If you experience any or all of these symptoms, you should consider adding more memory to your PC. Exactly how to install more RAM depends on your computer. For most models, it's a simple operation; you may be able to do it yourself.

If your PC is a desktop model and is just a few years old, odds are that it uses "memory modules," small circuit boards that attach to the main board of your computer. These modules are often referred to as SIMMs, for single in-line memory module.

SIMMs are characterized by one or more integrated circuits (ICs) attached to a small printed circuit board. At the base of this board is a row of small electrical contacts. These contacts mate with a connector on your computer.

Another form of memory module is the SIPP (also SIP), which stands for single in-line pin package. Like SIMMs, SIPPs comprise one or more ICs mounted on a circuit board. But instead of electrical contacts at the base of the board, the SIPP contains a row of tiny pins. The SIPP board plugs into a socket on your computer.

The trend in computer RAM is toward SIMMs, because they are cheaper to manufacture, so they cost less. You'll find that SIPP memory is about five to 10 percent more than SIMM memory.

Both SIMMs and SIPPs are fairly easy to install, although it is possible to install the memory backwards in the mating socket or connector. Improper installation can ruin your computer's motherboard, as well as the memory, so you must exercise extreme caution if you're installing your own RAM. See the sidebar, "Installing SIMM/SIPP Memory," for more details.

If your PC is older than a few years, it probably uses individual memory chips, called DIPs (for dual in-line pin) that are installed one at a time in sockets on the computer's main board. The chips have 14 or 16 little pins on the underside; these pins slide into the sockets and make electrical contact. See the sidebar, "Installing DIP Memory," for more information.

Of course, there's a limit to the amount of RAM you can install in your computer. The maximum RAM capacity depends on the specific brand and model of computer, but roughly falls into these lines:

Typical Maximum RAM Capacity	
Motherboard	
8088	640K
80286	2Mb
80386	16Mb
80486	16Mb

Memory Expansion Boards

Just because the motherboard of your PC won't accommodate more RAM doesn't mean you can't add it. Memory can also be installed using an expansion card that is plugged into one of the free slots in your PC. Memory cards were typical in the early days of PCs, and in fact are still common in the few 8088 and 80286 computers still manufactured. Memory cards aren't often used with the late-model 80386 and 80486 PCs unless you need to add gobs of extra memory, such as 32Mb or 64Mb.

To use a memory card, you first add the memory (SIMM, SIPP, or DIP) to the card, then install the card in the computer. The memory card must be engineered for the type of PC you're using. For example, you can't use a memory card designed for an AT-class computer with an 8088-based PC. The reason: AT computers use 16-bit expansion slots, and the old 8088 type use only 8-bit slots.

Technically, there's nothing stopping you from going the other way: using a memory card designed for an 8088 in a higher class computer, for example. However, doing so won't yield acceptable results. The memory flow is limited to the number of bits used in the expansion slot. The 8088-based PCs juggle only eight bits at a time, whereas the AT-class computers handle 16 bits at a time (80386 and 80486 computers manipulate 32 bits at a time). Obviously, you'll experience reduced efficiency when using an 8-bit memory card with a 16- or even 32-bit computer.

More RAM For Laptops

The typical laptop computer comes with one or two megabytes of RAM. Users of memory-intensive applications—like *Windows* and *OS/2*—of-



One of the largest direct suppliers of memory upgrade is Kingston Technology Corp., 17600 Newhope St., Fountain Valley, CA 92708; (714) 435-2600.

ten find that they need to increase the RAM in their laptops. For the past several years, laptop PCs have used SIMM and SIPP memory exclusively.

A number of laptop computers require proprietary RAM modules. SIPP, SIMM, and DIP memory is more or less interchangeable (except for the "speed" of the memory, as you'll see later in this article). However, because of the different electrical needs of laptops—specifically low power drain—memory modules designed for them are often specially manufactured. Obviously, the cost for laptop memory is often more than for generic desktop PC RAM. Expect to pay from 25 to 100 percent more for an equal amount of laptop RAM than you would for desktop RAM.

RAM For Laser Printers, Too!

If you have a laser printer, you probably know it uses RAM of its own. This memory is used to store text, graphics, and font information supplied by your PC. The printer collects all of the information for the entire

page. When the data is all there, the page can be printed. Obviously, this requires quite a reservoir of RAM.

The higher the resolution of the printer, the more memory required to render the pages. For example, to print a full-page graphic at the standard 300 dots per inch (dpi) resolution of most PC laser printers, you need at least a megabyte of RAM. In practice, full-page graphics at 300 dpi requires two megabytes. Extra RAM is also needed to hold downloaded fonts (including TrueType fonts used in *Windows 3.1*). Typically, your printer will complain about a lack of memory in one of several ways: the page isn't printed, part of the page is blank, part of the page is garbled, or an error message appears on the printer's liquid crystal display.

Your laser printer comes with memory already installed. For example, if you have an older Hewlett-Packard LaserJet Series II, it contains 512K of RAM. An HP LaserJet III, on the other hand, comes with a stock of one megabyte of RAM.

You can add more RAM by installing a memory expansion board. This board fits into a slot in the rear or side of the printer. (The exact location depends on the model of the printer.) Typically, the board can hold one, two, or four megabytes of RAM. Assuming you "populate" the expansion board with its maximum capacity of memory, you will provide 4.5Mb for the LaserJet Series II, and five megabytes for the LaserJet III.

RAM Densities And Speed

Differences in computer memory aren't limited to DIP, SIPP, and SIMM. First, there's a question of how much memory one chip or module can hold. Most memory modules used in 386-class and higher PCs

RAM SPEED

The speed of the RAM chips is expressed in nanoseconds, or billionths of a second. Here are the recommended minimum speeds for use with various motherboards. There's NO NEED to buy faster RAM, so save your money and purchase just what you need.

Motherboard Type/Speed	RAM Speed (nanoseconds)
8088, 4.77 MHz	200
8088, 8 MHz	150
8088, 10 MHz	120
80286, to 20 MHz	100
80386, 16 or 20 MHz	100
80386, to 33 MHz*	85
80386, to 40 MHz*	70

* Also applies to SX versions, and 80486; assumes microprocessor cache. (Note: These figures are conservative and are based on standard motherboard implementations; check the documentation that comes with the motherboard you are buying for the recommended RAM chips to use.)

hold either 256K or one megabyte of data. The one megabyte version uses higher density RAM chips—the integrated circuits used in the memory modules are packed with more memory cells. The most common memory modules are one megabyte.

In order to pack even more RAM into a limited space, manufacturers offer SIMMs and SIPPs containing four megabytes of memory. Such memory is designed for the 386 and i486 computers, but you should be aware that not all computers can accept it. Four 4-Mb memory modules are used to provide 16Mb of RAM.

Then, there's the issue of access time, or the speed of the memory chip. Technically, access time is the time it takes the chip to fetch data from one of its memory cells, and present it to the microprocessor in your PC. Slow chips cannot be used in fast computers, or errors may occur.

It's important to note that faster RAM won't make your computer faster. But slower RAM will make it slower, or completely unusable (that is, the memory can't keep up with the rest of the computer).

Finding RAM

Where do you find extra RAM for your PC? Mail order is a good place to start, although you need to know what you're looking for ahead of time. Check the ads in this magazine for mail order sources.

You can also purchase memory at most local computer stores, including the "super stores" like CompUSA. Their prices are slightly higher than mail order, but you get to take home the merchandise right after you pay for it. Plus, you can usually count on a higher level of assistance if you aren't sure what to buy.

Getting Your PC Used To More RAM

So you've just purchased and installed more RAM for your desktop PC, laptop, or laser printer. Your job isn't done yet.

To start, most PCs need to be told how much memory is available to them. (This isn't the case for laser printers, but see the next section for important details). On AT (286) and 386 computers, you must indicate the new allotment of RAM using a setup

utility. This utility is either built into the computer, or is included in the master diskettes that came with your computer. Run the setup program, indicate the amount of RAM (usually in bytes), and restart the computer.

Some computers, particularly the older XT type models, require you to change switch settings on the main circuit board in the machine. You must refer to the manual that came with your computer to see exactly how to set the switches.

If you're adding more memory to a separate memory card (the card plugs into the computer's main circuit board), you may need to set a series of switches, run a software setup utility, or both. Refer to the memory board manual for more details.

Although your PC may now recognize the additional memory you've installed, your programs may not be able to access it. Some programs, particularly the older ones like *WordStar Professional 4.0*, are designed to use the base memory of your computer, which is never more than 640K. (We mean IBMs and compatibles here; the Apple Macintosh and other brands follow a different convention.)

However, many newer programs, like *Windows*, *WordPerfect*, *Lotus 1-2-3*, and hundreds of others, can access installed memory over the 640K base, but only if you use a memory management program. *Windows* comes with memory management programs, which are loaded automatically when you install the software. Other memory management programs are available; one of the most popular is *QEMM* from Quarterdeck.

Configuring Laser Printer Memory

Unlike computers, most laser printers—including the Hewlett-Packard

LaserJet models—do not require that you set switches to indicate the amount of installed RAM. The electronics in the printer do this for you.

However, you may need to return

the printer to its default settings to force it to re-examine its memory. How you do this depends on the printer you own; check your user's manual. Failure to reset the default

settings will usually cause the printer to ignore the full memory cache. Print a test/diagnostics sheet to ensure that your printer recognizes all installed RAM. ■

Installing SIPP/SIMM Memory

Both the SIPP (single in-line pin package) and SIMM (single in-line memory module) memory modules are extremely easy to install. No tools are necessary. Assuming that you don't need to remove any existing memory modules, the job takes about a minute.

Before installing memory modules, you need to know about static discharge, and how it can be harmful to memory chips. Careless handling of the module can cause an excess of static electricity. You should always keep the memory modules in their protective bag or enclosure. Remove them only when you're ready to install the memory, and handle the modules by the sides only. NEVER touch the electrical contacts on the circuit board.

To install a memory module, first orient the front of the module with the front of the socket or connector in your computer. Some computers and memory modules include a notch that prevents you from installing the RAM backwards, but don't count on this feature to keep you from making a mistake. Consult the manuals that came with your computer and the memory modules for information.

Grasping the memory module by the sides, gently position the board over the socket or connector. You must be careful that the electrical contacts on the memory module are perfectly aligned with their mating connector on the board. When you're satisfied that the memory module isn't going in crooked, apply even but gentle pressure on the top of the module until it's firmly seated.

When installing SIPP memory, carefully examine the base of the module and look for pins that missed

their sockets. All pins must be properly in place. If you see a mistake, carefully remove the module, straighten out the bent pin (use a pair of small needle-nose pliers), and try again.

When installing SIMM memory, you may need to tilt the module to insert it into the connector. Once complete electrical connection is made, gently push the module down into its holding clamps. The clamps hold the module in place.

The job is a little tougher if you need to remove one or more existing memory modules from your computer. SIPP memory can be removed simply by pulling up on the module. SIMM memory, on the other hand, must be carefully removed by first undoing the hold-down clamps that keep the module in place. Use a small jewelers screwdriver to pry the clamps away from the module, but be careful that you don't break the clamps. Once the module is clear of the clamps, lift it gently away from your connector.



Installing DIP Memory

The process of installing DIP (dual in-line pin) RAM chips is a simple one. You don't even need a soldering iron or special tools. Your computer uses plug-in sockets that accept the RAM chips. Adding more memory is simply a matter of plugging chips into the empty sockets.

There are some caveats and general rules you should follow when installing RAM chips, however. Careless handling of the chips destroys them, and finding a faulty chip once it's in your computer can be difficult. It's best to install the chips slowly and carefully the first time, and avoid problems. Here are the details:

Before opening the protective plastic bag holding the RAM chips, be sure to discharge any static electricity from your body by touching the metal chassis of a grounded appliance. Static can destroy the innards of a RAM chip.

To install the chip, first locate the "clocking notch" cut into one end of the IC. You'll need to line this notch up with another notch in the empty socket. If you reverse the chip in the socket, and turn the power to your computer on, you'll damage the chip and it will have to be replaced.

Grasp the chip by its plastic edges—not by its metal leads—and gently insert it into the socket. Apply even downward pressure. If the chip starts to go in crooked, gently lift it back out and try it again. If you're having trouble seating the chip into the socket, gently rock it back and forth to ease it all the way in. Sometimes, the leads of the IC will be bent slightly outward and won't fit into the socket. If this is the case, gently squeeze the leads together a bit with your fingers. If, for some reason, you must take the chip out of the socket, grasp the chip by the ends and pull up. You may need to pry a stubborn chip out of the socket. Use a wooden nail file and pry up by one side then the other.

Before you close up your computer, double-check your work. If you're not filling up all the sockets, are you sure you used the right ones for the amount of memory you're adding? Are the chips all the way in their sockets? Is their orientation correct—notch matches notch? If everything seems okay, you can put your computer back together, turn it on, and test the new memory. □

COMPARISON CHART: MEMORY BOARDS

Make/Model	Bus Compatibility	RAM: Basic; Max.	Chip: Size; Type; Speed	Upgradable Chips?	RAM Disk	Other Features	Works With	Price
Above Board Plus I/O	XT, AT	512K, 2Mb	256K; DRAM; 150ns	Y	Y	I/O module: serial & parallel port, EMS 4.0 Memory Manager, software installation program; opt. 2Mb Piggyback memory	IBM PC, XT, AT, & compats.	339
Above Board Plus 8	XT, AT	2Mb, 8Mb	2Mb; DRAM; 120ns	Y	Y	EMS 4.0 Memory Manager, software installation program; opt. 2Mb Piggyback memory	IBM PC, XT, AT, & compats.	459
Above Board Plus 8 I/O	XT, AT	2Mb, 8Mb	2Mb; DRAM; 120ns	Y	Y	I/O module: serial & parallel port, EMS 4.0 Memory Manager, software installation program; opt. 2Mb Piggyback memory	IBM PC, XT, AT, & compats.	499
Orchid Technology RamQuest	XT, AT, ISA	1Mb; 32Mb	256K/1Mb/2Mb; SIMM; 80ns	Y	—	supports extended & expanded memory	IBM PC, XT, AT, PS/2 Model 30, & compats.	\$199 (OK)
RamQuest 16/32	MCA	0K; 8Mb	256K/1Mb; SIMM; 80ns	Y	—	supports extended & expanded memory	IBM PS/2 & compats.	269
STB Systems PowerMEG	AT	256K; 2Mb	256Kb/1Mb/4Mb; SIMM; 100ns	Y	—	16-bit memory access	IBM PC, XT, AT, & compats.	—
Tall Tree Systems JRAM AT-2	AT	2Mb; 2Mb	256K; DRAM; —	N	Y	EMS LIM 4.0 operation, piggy-back connector	IBM AT & compats.	\$299
JRAM AT-4	AT	8Mb; 8Mb	1Mb; DRAM; —	N	Y	EMS LIM 4.0 operation, piggy-back connector	IBM AT & compats.	349

Make/Model	Bus Compatibility	RAM: Basic; Max.	Chip: Size; Type; Speed	Upgradable Chips?	RAM Disk	Other Features	Works With	Price
Tecmar MicroRAM SC	MCA	0K; 8Mb	1Mb/2Mb/4Mb; SIMM; —	Y	N	BIOS level compat.	IBM 16-bit & 32-bit PS/2 & compats.	\$360 (0K)/ 580 (2Mb)/ 800 (4Mb)
ClassicRAM	AT	0K; 8Mb	512K/2Mb/4Mb; SIMM; —	Y	N	BIOS level compat.	IBM PC, AT, & compats.	390 (0K)/ 500 (512K)/ 610 (2Mb)
MicroRAM 386	MCA	0K; 8Mb	2Mb/4Mb/8Mb; SIMM; —	Y	N	BIOS level compat.	IBM 32-bit PS/2 & compats.	490 (0K)/ 710 (2Mb)/ 930 (4Mb)

MEMORY BOARD MANUFACTURERS**Acculogic, Inc.**

13715 Alton Pkwy., Irvine, CA 92718,
(714) 454-2441

Orchid Technology

45365 Northport Loop W., Fremont,
CA 94538

Intel Corp.

2200 Mission College Blvd., P.O. Box
58119, Santa Clara, CA 95052, (800)
538-3373, (408) 765-8080

STB Systems, Inc.

1651 N. Glenville, Ste. 210,
Richardson, TX 75801, (214) 234-
8750

Tall Tree Systems

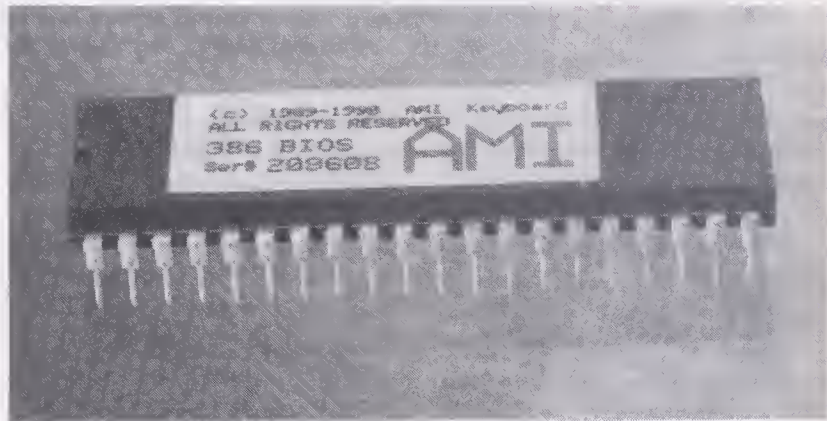
2585 E. Bayshore Rd., Palo Alto, CA
94303, (415) 493-1980

Tecmar

6225 Cochran Rd., Solon, OH 44139,
(800) 624-8560, (216) 349-1009

BIOS Upgrades— If Not Now, When?

Here are 14 reasons to upgrade your BIOS, and instructions on how to replace the BIOS chip.



Your computer is just a conglomeration of electronic and mechanical parts—a hard disk controller here, a memory chip there and a cooling fan back there. Like the Oz Tin Man, your computer needs a brain.

The Basic Input/Output System, or BIOS, provides the crude brains that make your computer's components work together. Without it, your computer is simply an overpriced, 40-pound paperweight. If necessary, you can even add your own brain transplant. A simple \$30 to \$90 BIOS replacement can supply faster performance and additional features.

What's a BIOS?

The BIOS is a collection of small computer programs embedded into a ROM (read-only memory) chip or chips, depending on the design of

your computer. That collection of programs is the first thing loaded when you start your computer, even before DOS (disk operating system).

Simply put, the BIOS has three main functions:

1. Tests your computer's components when it's turned on. This is called the Power-On Self-Test, or POST. The POST tests your computer's memory, motherboard (the PC's main circuit board), video adapter, disk controller, keyboard, and other key components.

2. Finds the operating system and loads, or "boots" it. This is called the "bootstrap loader" routine. If an operating system is found, it's loaded and given control of your computer.

3. Once an operating system is loaded, the BIOS works with your processor to provide software programs easy access to your computer's specific features. For example, it tells

your computer how to work with your video card and hard disk when a software program requires it.

With these responsibilities, the BIOS is like a computerized traffic cop, ensuring your computer's safety when it starts and providing smooth flow for the demands your software and DOS place on your system.

For any program to work with your computer, it usually works through the BIOS. The BIOS is a collection of programs, or routines. To use a BIOS routine, such as reading a file off your computer, your software program must issue the right interrupt, a special instruction to your microprocessor. The interrupt causes the microprocessor to stop in its tracks and start the requested routine. It does this by looking in a table of interrupt vectors to find out where in memory the BIOS routine is located. That routine is then run.

Accessing CMOS

On AT (286) and newer computers, the BIOS has another function; it lets you change your computer's configuration without having to open your computer and set various DIP switches and jumpers (small caps that connect two pins on a board). Usually during your computer's warm-up, you can tell your computer about added memory, disk drives, a different video adapter, or a change in date and time.

The BIOS doesn't actually hold this information. Instead, it provides a setup program to write this information to a CMOS (complementary metallic oxide semiconductor). The CMOS is a special type of memory chip that requires little power to store information. Even when your computer is turned off, its memory contents are saved by a trickle of power from an AA or small nickel-cadmium battery. By using a CMOS and the BIOS setup program to access it, you can configure your computer from your keyboard rather than wrestling with a screwdriver. On a PC or PC/XT, you still must open your computer and set the DIP switches and jumpers.

True Compatibility

The BIOS is also the heart of what makes your PC compatible. It provides standard rules for using the various electronics inside your computer.

The first BIOS appeared on the IBM PC in 1981. If your computer is to be compatible with the PC standard, then your BIOS must duplicate the operation of that first BIOS.

Of course, manufacturers of IBM-compatible computers simply cannot copy the IBM BIOS. Like any software program, the BIOS is protected by copyright law. Instead, compa-



ROM Chip Removeable Points: With a chip puller, pry just a bit on each end, without using excessive force. Too much pressure can result in damage to the motherboard.

nies use a BIOS that mimics the operation of the IBM BIOS without copying IBM's code. Instead of creating their own BIOS, many computer manufacturers buy a BIOS from specialists like American Megatrends Inc. (AMI), Award Software, Microid Research, or Phoenix Technologies Ltd. These companies then usually "flash" the BIOS onto programmable chips for use in their computers.

Providing BIOS code is big business. Phoenix Technologies, for example, receives about \$20,000,000 to \$30,000,000 each year by selling BIOS chips. With an IBM-compatible BIOS, companies like Gateway 2000, Dell Computers, and Zeos International have been able to offer IBM-compatible computers for years.

Although companies try to mimic the first BIOS, the evolving PC standard requires the BIOS to adapt to changes in technology. For example, a different BIOS is needed for different motherboards (the computer's main circuit board). Each motherboard relies on a chip set, which is the motherboard's core. The chip set provides a computer with characteristics that hopefully set it apart from "the other guy's." Popular chip sets include VLSI, Suntac, Opti, and Chips & Technologies. However, the number of chip sets doubles every year,

requiring a BIOS tailored for each.

Extending Your BIOS

The BIOS not only provides IBM compatibility but also the ability to recognize some accessories you might add to your computer.

The first IBM PC had its BIOS set in stone. Extra programming code couldn't be added to

the small domino-sized chips inside that first computer. This limitation posed a problem, since the first PC BIOS didn't anticipate such things as hard disks or requiring more than 64K of memory. The PC-2, the PC-I's replacement, featured a new BIOS that was flexible, an innovation that continues today.

Imagine that you just installed a new VGA video card into one of your computer's expansion slots. As your computer warms up, the BIOS performs its self-test (POST) and accesses the basic BIOS programs. Then, the BIOS searches for any extra BIOS code needed to run that VGA card. The ROM chips containing those extra pieces of BIOS code aren't found on your motherboard. Instead, they are found on the add-on card itself and loaded.

Of course, the process isn't perfect. Sometimes, the default address where a card looks for a BIOS routine is already used by another card, making the new add-on unusable. The DIP switches and jumpers on expansion cards then let you reassign the address so the new add-on works.

If you own a PS/2 or any computer that uses MicroChannel architecture (MCA), then you don't need to worry about such hardware conflicts. When the PS/2 was introduced in 1987,

IBM revised its BIOS to support MCA. As a result, jumpers or DIP switches no longer had to be set. All configuring of expansion cards is done by software.

Another drawback of BIOS extensions is not only possible hardware conflicts but simply the valuable memory BIOS extensions occupy. If you have a 386 or 486i computer and DOS 5.0, you can reclaim the unused portions of the 128K reserved for BIOS extensions. This reclaimed memory can be set aside for upper memory blocks, or UMBs. UMBs then can be used to store memory-resident programs or part of the operating system, thus, preserving more of your 640K workspace.

But there are good reasons for add-on cards to use BIOS extensions. One reason is speed; the basic BIOS routines can be slow. For example, all IBM BIOS routines place characters one at a time onto the screen. It's much faster to bypass the BIOS and blast text onto the screen. Also, your use of hardware may be restricted by the BIOS. For example, an add-on card may let you format a floppy disk for use by a different computer system. However, the basic BIOS routines restrict you to reading, writing, and formatting disks with the standard IBM disk formats. BIOS extensions on ROM chips let these add-on makers overcome these hurdles. Today, many hardware manufacturers enhance or bypass the BIOS by writing their own programs to control their products.

When to Upgrade

Adding a new BIOS can allow you to use new accessories for your PC. With a new BIOS you can use software and hardware you otherwise couldn't use or could use only with difficulty and frustration.

Yet, upgrading your BIOS isn't a

panacea. It may not solve some inherent incompatibilities or limitations of your computer, since people have misconceptions about the BIOS. For example, a PC/XT doesn't require a new BIOS when a high-density disk drive is added. The necessary BIOS code is on the disk controller. Likewise, you can't add a feature like shadow RAM if your motherboard design doesn't support it. (Shadow RAM is a feature that copies some of the BIOS programs into your PC's faster memory rather than the slower ROM.)

So when should you update your BIOS? Since the BIOS is the glue between hardware and software, it can be an important part in your PC's error-free or increased performance. Here are 14 reasons to update your BIOS:

1. To support DOS 5.0. With DOS 5.0, you can load device drivers into the High Memory Area (HMA), giving you more memory for work. However, some peripherals (hard disk drives, etc.) may not work properly when drivers are loaded "high." A new BIOS can solve these problems. It's often recommended that BIOS chips manufactured before 1989 be replaced to support these features.
2. To remove conflicts with *Windows* and OS/2 software. According to industry sources, this is the single most popular reason why people buy a new BIOS. The demands *Windows* and OS/2 place on your computer hardware, cause incompatibilities and glitches. The problems are often erratic, varying from one PC to another, but common complaints are the inability to use *Windows*' enhanced mode or the frequent locking up of one's computer.
3. To support high-density or new disk drives. If you want to use the new 2.88-megabyte disk drives with your AT (286) or greater computer, you'll need an updated BIOS. Likewise, an

AT may need a newer BIOS to support 1.44Mb drives. (Some PC makers didn't equip early AT clones with the newer BIOS chips to support this high-density drive.) You can check your BIOS setup program or owner's manual to see if your computer supports these higher-density drives.

Once the proper BIOS upgrade is installed, adding a new disk drive is as simple as selecting the correct drive from the setup program. (For the PC and PC/XT, adding a 3.5-inch or high-density (1.2Mb) 5.25-inch disk drives doesn't require a new BIOS. The floppy disk controller for such drives usually provide the needed BIOS code.)

4. To support more and newer types of hard disks. The BIOS contains a table of possible hard disk drives, including the heads, sectors, and cylinders of each. This is called the drive table. The BIOS uses this table to recognize your hard disk.

The drive table is limited in size. The first 24 entries often match those in the IBM BIOS. The remaining entries vary from one BIOS manufacturer to another. To support larger and newer hard drives, such as the popular IDE (Integrated Drive Electronics) models, the BIOS may need to be updated.

How do you tell if the bios needs to be updated? An IDE drive may be added using your current BIOS if the BIOS supports a newer feature that lets you define your drive. That is, it lets you enter the characteristics of your drive. With AMI BIOS, drive type 47 is reserved for the user-defined drive. With a Phoenix BIOS, you can define drive types 48 and 49. However, if you are adding a gargantuan one-gigabyte or larger drive (1024Mb), there may not be enough room for the digits required. If you can't define your drive and the new hard disk you wish to add isn't listed in the drive table, it's time for a new

BIOS.

Recent BIOS chips can automatically sense the characteristics of IDE drives so you don't even have to open a manual. For example, pressing the question mark key (?) interrogates the drive.

5. To prevent data loss and improve drive performance. Some older BIOS chips (pre-April 1990) may have timing problems with IDE drives. These problems could cause some data loss. By supporting newer drives, the BIOS can use the proper timing for your hard disk.

6. To provide Novell network compatibility. Novell Network software looks for a specific hard disk in the BIOS drive table. If the drive type isn't listed, the computer won't work with the network. A new BIOS can provide an updated list of the drives available. The BIOS vendor may have to hard-code the drive parameters into the chip.

7. To support enhanced keyboards (101/102-key). Sometimes, you may want to use an enhanced keyboard, one with 101 or 102 keys on it. Occasionally, the BIOS plays a role in its compatibility.

8. To provide better power-on diagnostics testing. Today's BIOS chips provide faster and more thorough testing of your computer as it warms up. During the Power-On Self-Test (POST), various components are checked. These include: your PC's central processing unit (CPU), system timer, the video display adapter, and its built-in memory (the computer's main memory), the keyboard, and all disk drives. If something is wrong, you will often hear a series of beeps and see a brief message, which help you diagnose the problem. But remember, most PCs beep once or twice to signal the end of this start-up test.

9. To support VGA (virtual graphics array) monitors. Sometimes but

IT supports VGA/EGA rarely, your BIOS may have to be updated to support VGA. Some video adapters require a BIOS after a certain date.

10. To provide more than two serial (COM) ports. Sometimes, a BIOS provides support for extra serial ports (up to four). These extra serial ports can be used for mice, modems, or serial printers. For example, if you need to redirect printing from LPT1 (your first parallel printer port) to COM3 (your third serial port), then you would need to get an updated BIOS.

In most cases, your computer can accept extra serial devices without buying a new BIOS. For example, many modems can be configured for COM3 or COM4. The communications software often supports those extra ports by writing programming code directly for the modem, bypassing the BIOS. Check your software before buying a new BIOS.

11. To provide password security. Among the new bells and whistles of some BIOS models is a feature to provide password security for your computer. You enter the password each time you start or reboot your computer. If you don't know the password, you can't get in.

12. To enhance your keyboard. Many BIOS chips let you change the typematic (repeat) rate of your keyboard as well as the delay before a keystroke is repeated.

13. To change drives to boot from. Some BIOS chips let you specify which drive the computer should first check for the operating system. Usually, a computer first checks the floppy disk drives (A then B, if present) and then drive C. By changing the boot-up sequence to drive C then A, you can quickly start your computer and save wear-and-tear on your disk drives.

Some BIOS products even let you swap the order of floppy disk drives,

so that drive A becomes B and vice versa. This can be handy in rebooting your computer from a different-sized diskette in drive B or easing the installation of software that seeks drive A but requires the size and format of drive B. (In this last case, of course, you can use the DOS ASSIGN command to swap drives temporarily.)

14. To support up to four floppy disk drives. Some newer BIOS manufacturers support up to four disk drives. Why would you need four disk drives?

You could have a newer 2.88Mb drive, a 1.44Mb drive, a 1.2Mb drive, and a 360K drive. One advantage of having a 360K drive is that you can confidently give someone a 360K disk to be read on their computer. (Some computers have a difficult time reading data on a 360K disk that's been formatted at the lower density in a 1.2Mb drive.) You can have four floppy disk drives without a new BIOS, but then drivers would need to be loaded.

Checking the Age of Your BIOS

Before you rush out to buy a new BIOS, you may want to find out the age of your current one. With a BIOS, the date is as important as the version number is for your software programs.

The date is encoded into the BIOS chip itself. Instead of opening up your computer or buying a special utility program, you can find out the date by using a simple DOS program. Run the DEBUG program located in your DOS directory. From the DOS directory, type:

DEBUG (press ENTER)

A hyphen (-) prompt appears on the left side of the screen. Then type: D F000:FFF0 (press ENTER)

A row of numbers appears. The BIOS date should appear in the right-hand column. Write down the date.

To exit: DEBUG, type:

Q (and press ENTER)

You can also create a BASIC program to display the BIOS date. Simply enter these four lines:

```
10 DEF SEG = &HF000
20 FOR x = &HFFF5 TO &HFFFF
30 PRINT CHR$(PEEK(x));
40 NEXT
```

Replacing the BIOS

Like a computer manufacturer, you too can buy a BIOS chip. A handful of mail-order companies specialize in replacement BIOS chips. You need to provide certain information about your computer, including:

- Size of the BIOS chips. To determine this, a number is printed directly on the chip. It may or may not be covered by a label. For example, the number may be "27C128."
- The chip set used on your motherboard. You can discover the chip set by looking for a large square chip about the same size as the central processing unit (CPU). Record the numbers off the chips. Some manufacturers include VLSI, Suntac, Opti, and Chips & Technologies. If no chip set is found, your computer may use discrete logic. To determine what BIOS you can use, consult your salesperson.
- If you currently use an AMI BIOS, simply record the reference number displayed as your computer warms up.

When you order a BIOS upgrade, it usually means installing two chips. However, newer computers may only need one chip. The street price of a BIOS chip varies with the type of computer and manufacturer. Some BIOS makers provide more features than others. Below are approximate street prices:

PC & PC/XT \$59-\$79

286	\$79
386SX & 386DX	\$69-\$89
486i	\$79-\$99

Sometimes the keyboard controller chip (chips #8042, #8242, or #8742) has to be replaced as well, since it's a partner to the BIOS. This controller costs \$19 to \$39. It's usually replaceable, although the true-blue IBM AT models 5162, 5170, and 5170/339 have it soldered to the motherboard.

Replacing the BIOS is a relatively easy affair. First, you should go into your BIOS setup program (called CMOS), and print the screens or jot down the facts about your current computer, such as the amount of memory and, more importantly, the various parameters for your hard disk. You'll need to re-enter this information after the new BIOS is installed.

Installation usually requires removing the current BIOS and inserting the replacement chips in the same slots and then running the BIOS setup program.

To remove the BIOS, use a special-

ized ROM puller. Or, use a small screwdriver or the lip of extra expansion slot brackets to slowly pry up the BIOS. To avoid ruining the BIOS, alternate prying up each side until the chip is free.

But before removing the original BIOS, carefully note the orientation of its notches. When you install the new BIOS, ensure that each chip (if there's more than one) is installed with its notch in the same direction. Otherwise, the BIOS will be destroyed when you turn on the computer's power. You'll know when that happens; a small flash of light is emitted.

When you turn on the computer, the BIOS will probably report an incorrect configuration and force you to enter its setup program to make the changes. After saving the correct information, your computer should restart and behave normally with the new BIOS.

Upgrading the BIOS may not be for everyone, but it may be necessary to use the features of this industry's newest hardware and software. ■

ROM BIOS upgrades:

Here's a list of BIOS suppliers.

HK Systems Inc.
3959 Beltline
Addison, TX 75244
(214) 392-1852
Fax: (214) 385-9044

Micro Firmware Inc.
1430 West Lindsey St.
Norman, OK 73069
(800) 767-5465
Fax: (405) 321-8342

SmartMicro Technologies Inc.
143 Triunfo Canyon Road
Westlake Village, CA 91361
(800) 422-9979
Fax: (805) 371-0012

Unicore Software
1538 Turnpike St.
North Andover, MA 01845
(800) 800-2467
Fax: (508) 683-1630

Upgrades Etc.
Thuna Technologies
2432-A Palma Drive
Ventura, CA 93003
(800) 955-3527
Fax: (805) 650-6515

USA Electronics Inc.
9090 N. Stemmons Freeway
Dallas, TX 75247
(800) 332-8434
Fax: (214) 631-4817

To Get Express Performance Out of Your Computer

Take The Local Bus

EISA, ISA or MCA? If that wasn't enough to confuse you, now there's yet another called Local Bus. Here's what it's all about.

Computer users are demanding. The more you give them, the more they want. Nowhere is this truer than when it comes to system performance. To keep up with the demand for faster computers, industry designers have developed several families of chips ranging from the relatively slow 8086 to today's blazingly fast 50-MHz 80486. But speed developments didn't end with chip design. To accommodate these faster microprocessors, faster and better ways of interconnecting the chips to the peripherals that make up a computer system had to be devised. Hence, the birth of several bus standards that today include ISA, EISA, and MCA.

The new chips and new bus designs adequately satisfied users' demand for higher speed until Microsoft came out with *Windows 3.0*. With its graphical user interface (GUI) and its need to move millions of bits of image data

around, system performance started to bog down. Things got so bad, that Microsoft immediately embarked on a revision to speed things up. The revision, *Windows 3.1* is out. It has helped the problem to a limited extent, but not enough to quiet the ever more vocal group of dissenters who demanded better performance. Board manufacturers started producing special *Windows* accelerator boards that also helped a little.

Even with the accelerator boards, computer systems face a log jam. The current buses only operate at a paltry 8 MHz for EISA systems and 10 MHz for MicroChannel systems. No matter how many improvements you make elsewhere in the system to speed up the display of graphical data, you still have to move megabytes of data. That's where the problem arises.

Finally, someone got the bright idea of coming up with a new bus structure (a fourth standard) that

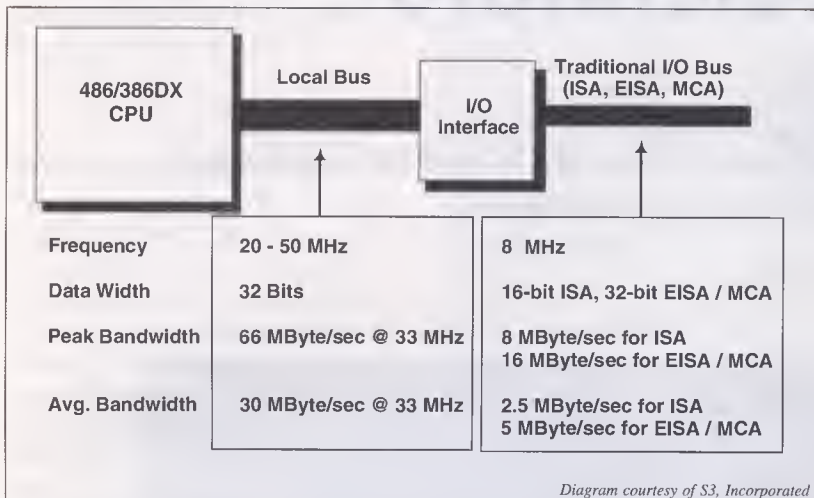
would be linked directly to the system's microprocessor and would operate at the microprocessor's clock speed, which today ranges from 16 MHz to 66 MHz.

The Local Bus is simply a 32-bit wide bus that connects directly to the system's microprocessor. Not all accessories can benefit from using the bus, which is why it's not a bus that's implemented by itself. Instead, it's added on to an ISA or EISA system. The Local Bus uses a special motherboard with Local Bus slots. You can then plug a Local Bus video display card into one slot and a Local Bus disk controller into the other slot.

While the Local Bus concept was only "discovered" for the PC this year, it's not really a new concept. It has been used for a while on Apple's Macintosh. There it's called the "processor direct slot."

Before the advent of the Local Bus, video controller cards had to be con-

Bandwidth Comparison: Local Bus versus I/O Bus



Like EISA and MCA, Local Bus also handles information 32 bits at a time, but unlike the other bus structures, Local Bus is linked directly to the microprocessor and operates at the system's clock speed.

connected to the system via the expansion bus. This bus limits the speed at which the controller can work in several ways, including: lower clock speeds, limited data transfer rates, and delays caused by arbitration (deciding which peripheral gets control of the bus first). While technically it's possible to speed up the EISA version of the bus by increasing its speed, this cannot be done because of the need to maintain compatibility with ISA system peripheral cards. The other bus that's available is the MicroChannel bus and is completely controlled by IBM. Only IBM can modify its bus design.

Video display cards and hard disk controllers, whose task it is to move huge amounts of data as quickly as possible, will benefit from the Local Bus and thus are ideal candidates for Local Bus implementation. To date, most of the action has been in the display arena and a number of card manufacturers have already announced Local Bus versions of their display cards.

Computers with Local Bus capa-

bility started appearing early this year, and for the most part, have realized the promise of increased performance. The performance improvements in systems that use Local Bus are truly spectacular, with speed improvements as much as fifteen times faster for ISA machines and five times faster for EISA units. The best thing of all is, that the cost to implement a Local Bus is low. Industry pundits estimate that it will add only between \$25 and \$50 to the total cost of a new computer system.

There is, however, one big problem with the technology: So far there's no industry standard. VESA, the Video Electronics Standards Association, is hard at work on coming up with a standard. In fact, one is expected by the Fall. There are several competing and complementary approaches to Local Bus that are vying for the top spot. VESA is working heavily with Intel, the chip manufacturer that developed the microprocessors used in PCs, to insure that whatever approach is finally approved will leave room for growth in

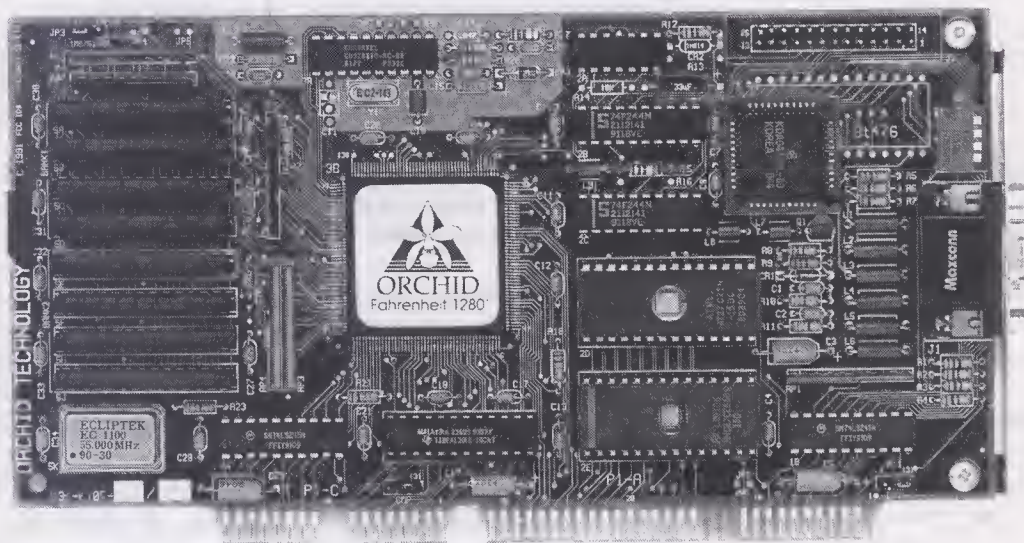
the development of microprocessors. Another chip manufacturer, OPTi Computer Inc., has come up with a Local Bus spec that's being used by several computer manufacturers. However, it's unlikely that in the long run, the OPTi specification will become the standard. Nevertheless, if you're looking to get a fast system now, there's no reason not to. As long as you get the display controller from the computer manufacturer, you won't suffer any great consequences, unless you try to upgrade your display card at some time in the future. Display speed is so fast, however, that it's not likely to be necessary to upgrade your display card.

Remember that the cost of moving to Local Bus will be a new computer. You must purchase an entirely new motherboard--in effect a new PC. Manufacturers that already have Local Bus machines available are: Micro Express, NEC Technologies, Essence Group, Comtrade, CSS Laboratories, and Dallas PC, to name just a few.

When considering a Local Bus computer, try to get one that supports not only a display card, but a disk controller, too. Alpha Research, which doesn't make a computer, does manufacture the Series 400 VL 475 motherboard and controller kit. The kit comes with a caching disk controller. By the way, chances are pretty good that the Alpha Research board will comply with the VESA standard; Alpha's president, Warren Lee, is on VESA's Local Bus standards committee. Two types of controllers are available, an IDE controller and a SCSI controller. If you do use a Local Bus disk controller, you'll get an astounding increase in speed. For example, on non-Local Bus computers, sequential disk seeks could take about 3.5 ms. With a Local Bus disk caching controller, the time drops to a mere 0.01 ms. ■

Video Accelerators

Accelerator boards with high speed video RAM and video processors turn sluggish GUIs into lightning fast performers.



You want to upgrade your system, but you're not sure where to start. In this article, we compare the standard VGA graphics board to VGA boards with a *Windows* accelerator chip that increases the performance of your monitor and video board while running *Windows*. We also look at the different memory options you can buy and how memory affects the number of colors you can generate on your monitor.

When you look at your system, literally as well as figuratively, what do you see? Although your CPU probably comes to mind first, your greatest amount of interaction is with your video subsystem—your

computer's video card and monitor.

Unlike some changes you can make, such as adding memory, upgrading software, or buying a larger chassis with a new power supply, you'll see immediate changes when you upgrade video capabilities. For example, if you currently have a monochrome monitor without graphics capabilities, upgrading your video card alone will provide a dramatic improvement in how you view and use your software.

Small Changes, Huge Results

It doesn't take much to see a differ-

ence. The addition of four-color monochrome graphics means that you can create charts, display four "colors" (standard, bold, reverse, and blinking text), and run games that require a graphics adapter.

If you have a CGA monitor (such as the units IBM shipped with its original ATs), upgrading your graphics card and monitor to VGA will result in even more dramatic changes. CGA displays minimally acceptable graphics, but very poor quality text. Upgrading to VGA or Super VGA requires very little technical expertise and will produce excellent graphics and very clear text.

Many mail order companies, small

resellers, and large computer dealers sell video subsystems, including a SVGA graphics card and monitor, ranging from less than \$350 to more than \$1,000.

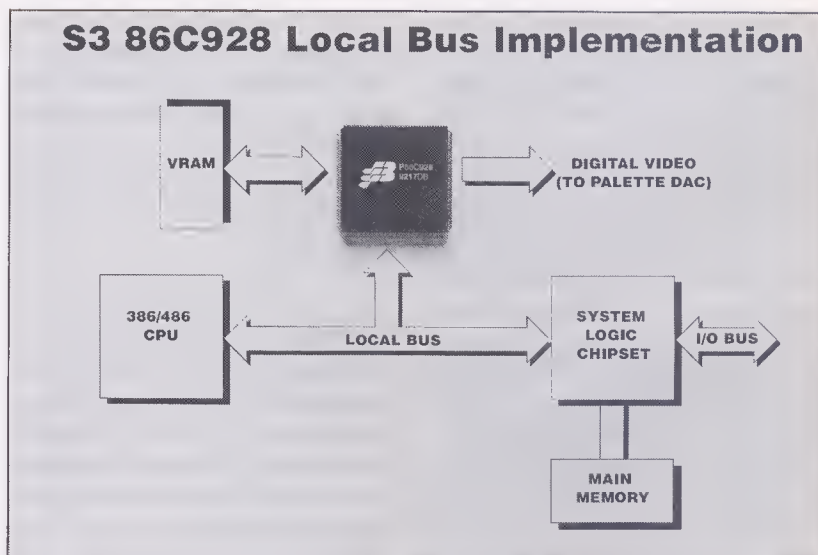
How Much Video?

The obvious question is: How much video do I need? The answer, however, isn't as obvious. The amount of video you need is directly dependent on the type of software you use, your computer, and the most significant intangible of all—your needs.

Before we discuss the components of the video subsystem, we first need to lay some groundwork. The VGA standard defines a display of 640 x 480 pixels by 480 pixels. A pixel is a Picture Element—a dot that effectively makes up everything you see on the screen. A resolution of 640 x 480 means you have 640 dots from side to side and 480 dots from top to bottom. Super VGA is 800 x 600, although you might see 1024 x 768 defined as SVGA. That definition for the higher resolution isn't precisely accurate because it isn't defined by the American National Standards Institute (ANSI), the standards organization that's recognized as the organization that's responsible for most standards in the U.S. For the sake of this article, however, the higher resolution is considered SVGA.

Many of today's video cards offer 256K, 512K, or 1Mb of DRAM. Some of the low-end video cards provide sockets to increase memory; others don't. To display an image at a resolution of 1024 by 768 instead of a 640 x 480, the system has to generate 786,432 pixels—that's enough to slow down even the fastest 486i.

The more RAM a graphics card has, the more colors it can create. Some video boards use standard DRAM, the same type found in computers. Other boards use Video RAM,



The S3 86C928 offers accelerated 16-bit high color or 24-bit true color in high resolutions with high refresh rates. Performance gains of 30x over SVGA can be achieved in high resolution graphics modes.

a more sophisticated and faster RAM chip. On boards with equal amounts of VRAM and DRAM, respectively, the board with the VRAM will be faster and provide more colors than the board with the DRAM.

Colors on a computer monitor are created by mixing colors from three light guns in the monitor's picture tube—red, green, and blue. If a graphics card has more RAM, it can store more instructions to tell the guns where to place each color. Colors are generated on the screen when the guns cause one of the pixels to glow. If all three guns electrically excite three pixels in the same location on the screen, you see white. The rest of the rainbow is created based on the percentage of light being generated by pixels in concert with other pixels adjacent to them.

Many of today's high-speed graphics boards are sporting more and faster RAM, as well as chips specifically designed to relieve the system CPU of the graphics processing. The separate microprocessor on the graphics board becomes responsible for processing all graphics instructions. As a

result, the graphics processing speed is increased due to the dedicated processor; the system processing is increased because the computer CPU no longer has to be involved with generating graphics images. Video boards with dedicated graphics processors are called accelerator boards.

Who Needs What?

In this article, we'll look at two classes of users. One user has a 286- or a 386-based system running DOS but not *Windows*, and uses mostly word processing, database, and spreadsheet software. The other user has a 386SX or faster system and runs several *Windows* applications more than six hours in an eight-hour day.

In the first case, high-end graphics aren't a significant portion of the user's daily tasks. Although each of the three major application packages will benefit from the addition of color, only the spreadsheet requires a variety of colors, and then only for the creation of graphs.

This user reads large volumes of text. The minimum graphics level

he or she needs is standard VGA. A low-cost VGA board has 256K of DRAM, but only displays 16 colors in a standard alphanumeric format of 80 columns by 25 lines on your monitor at 640 x 480. The limitations of the number of colors and resolution are a result of determining how many bytes of memory are required to tell the color guns in the picture tube how many and what colors of pixels must be illuminated. With more memory, the boards can store more information about each pixel. Boards with 256K of RAM generally sell for no more than \$75, and can be purchased for as little as \$25.

If you want to display 256 colors, which provide greater clarity and color gradation, you need 512K of DRAM. By boosting your DRAM to 1Mb, some video boards with special RAMDAC chips offer you a palette of up to 32,768 colors; however, you can only view them at the 800 x 600 resolution or 256 colors in 1024 x 768 resolution. If you want to display text at a resolution of 1024 x 768, the resolution of many SVGA monitors being sold today, you need a 16-inch monitor. (The laws of physics limit the number of pixels on a 14-inch monitor, the type most users have in their home or office. In order to get 1024 x 768 resolution on a 14-inch monitor, the dot size would be so small as to make the text virtually unreadable. Increasing to a 16-inch monitor virtually doubles the number of pixels on the monitor, making that resolution possible for text. However, 16-inch monitors are expensive—about \$1,000.)

Some graphics boards boast that they can display 16.8 million on-screen colors. At this level, you're looking at photographic-quality images on screen. To reach this level, you need to use a 24-bit graphics card with 1Mb of RAM.

With a 24-bit color board, one byte

of data is used to instruct each of the three color guns in a video monitor. With 15-bit color, five bytes of data do the same job. Most popular video boards today are 15-bit boards. A 24-bit board provides 63 percent more data to define colors than a 15-bit board.

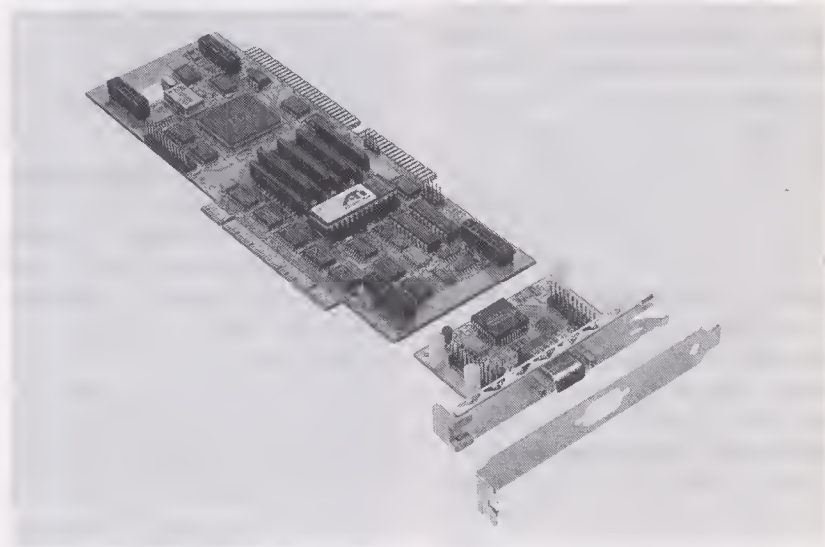
A Windows Accelerator

The first user probably does not need an accelerator board. Our other user, however, runs *Windows* at least 75 percent of the time and should consider one of the graphics boards that include a graphics accelerator chip. These chips allow you to speed up the presentation of graphics images and *Windows*, even on a high-priced, high-performance system. Let's put this in perspective. When changing from one application to another in *Windows*, a system without an accelerator board might take up to 30 seconds to generate the new screen. With the accelerator board, generating the new screen could take a couple of seconds or less.

There are three main types of ac-

celerator boards: fixed function, programmable, and VGA pass through. Fixed function boards are just that: As technology improves, these boards will continue to deliver the same performance they deliver today. Programmable boards, which sell in the \$1,000 range, provide an upgrade path for those users sophisticated enough to be able to program the boards. These boards are designed for power users who have considerable programming skills.

VGA pass-through boards have no VGA capabilities built in. These boards require that the existing VGA board remain in the system, with the accelerator board adding the processing power necessary to transfer the graphics processing from the system's CPU to the graphics board. The better your original VGA board, the better the performance of your video subsystem. With a pass-through card, you'll need to run a ribbon cable from your original card to the accelerator card. The pass-through cards tend to be a little less expensive, but they require you to use two bus slots on your motherboard instead of the one



ATI Technologies, Inc.'s 8514/ULTRA features Crystal Screen Fonts (300dpi) and dual bus architecture.

used by VGA accelerator boards with on-board VGA capabilities.

Your dealer might tell you about the S3, Weitek, Chips & Technology, Mach 8 (ATI proprietary), or Texas Instruments accelerator chips. All are high quality chips, but S3 seems to have the lead in terms of brand-name users of fixed-function boards, the most popular boards available today.

Compatibility

Even if you have an XT-compatible, you can benefit from many of the capabilities of graphics boards designed for the 16-bit AT bus, although it's unlikely that an accelerator board will increase the performance of an XT. Most graphics boards support 8-bit motherboards, giving up some of the higher resolution and speed. Adding an accelerator board to an XT provides processing power that the XT bus can't support. It's not unlike putting a race car engine into a subcompact car for street travel. Although the subcompact certainly could use the power boost, it's not designed to take advantage of the engine's capabilities.

Our user running *Windows 3.1* may have compatibility problems with the board's device driver and *Windows*. *Windows* provides a READ.ME file as part of its start-up procedure. In this file, there's information about how to set up *Windows* and which device driver to select so that *Windows* will run with the new board. Some of these changes necessitate that the user change the WINDOWS.INI file, one of the program's main setup files. The READ.ME file includes instructions on how and where to make the changes, as well as instructions as to what to do if you make a mistake. Like most Microsoft Documentation, the READ.ME file is complete and

should be able to guide you through the changes without too much grief. All *Windows* users, regardless of their graphics boards, should read this file and keep a copy of its printout for future reference.

Today, some computer vendors are building standard or super VGA graphics directly onto their system boards. If you want to use the graphics capabilities of the motherboard, you don't have to buy a graphics board. But if you want the advantages of the accelerator board technology, you'll have to disable the graphics board capabilities. Consult your system documentation to see how to disable the built-in graphics board. Before you do this, however, make sure that your vendor hasn't built in a graphics accelerator. You might already have the capabilities you desire.

One new technology that might

offer even faster video acceleration is the local bus, which requires that the video technology be installed on the motherboard. The local bus takes video off of the standard AT bus and puts it on a direct line to the CPU. As a result, there's virtually no bus delay for video processing. (See *Take The Local Bus* elsewhere in this issue.)

Software Support

Virtually all video boards today are shipped with drivers for the most common software, such as *Windows* and *AutoCAD*. Be sure to make sure that your board of choice has the appropriate drivers for your applications.

Installing the graphics board is relatively easy. As with any installation, you must turn the system power off and remove the power cord; some systems require that all cables be

Companies Featured

ATI Technology Inc.

3761 Victoria Park Ave.
Scarborough, Ontario, Canada
M1W-3S2
416-756-0718

Chips & Technology Inc.

3050 Zanker Rd.
San Jose, CA 95134
408-434-0600

Hercules Computer Technology

921 Parker Street
Berkley, CA 94710
510-540-6000

Orchid Technology

45365 NorthPort Loop West
Fremont, CA 94538
510-683-0300

S3 Inc.

2880 San Tomas Expressway
Santa Clara, CA 95051
408-986-8144

Texas Instruments

13400 North Central Expy.
Dallas, TX 75265
800-232-3200

Video Seven

46221 Landing Parkway
Fremont, CA 94538
510-623-7857

Weitek

1060 East Arques
Sunnyvale, CA 94086
408-738-8400

removed. Remove the chassis cover and find the graphics board. Unless you have a high-end system with an 8515 graphics adapter, there are no internal cables to consider. (If you're running an 8515 monitor, there will be a ribbon cable on the top of the card. Remove it as well.)

If your board has DIP switches, you should set them before you install the board. Consult your board documentation for the proper settings. Some boards, such as those from ATI Technologies, have no switches and automatically configure themselves.

Once the switches are set and the board is put into place, replace the system cover and plug in the cables. Installation is that simple.

If you have a 286 or later system, you might have to update your CMOS setup with new information. The CMOS setup is part of every system since the 286. It requires that you program in your system configuration. Some CMOS setups are very cursory; there are very few questions to answer. Others can be quite complex. You might have to update your CONFIG.SYS and AUTOEXEC.BAT files as well to load new device drivers. Some of your application programs might also require that you update your video subsystem to get the most out of your color monitor.

If you have a 1024 by 768 monitor that scans at 48 KHz, you can display 256 colors easily with a graphics board and 512K of RAM. If you need to display higher resolution, you probably will need to buy a larger monitor and add a graphics board with 1Mb of RAM.

One way to determine if drivers are available, either bundled with the graphics card or from a third party, is to call the manufacturer directly. No amount of fancy features makes up for the inability to run your software. While this might be impractical with

some generic video cards from overseas, it's possible with cards from the major manufacturers.

The technical support personnel will be able to tell you if your software is supported; many will be able to send you a list of all the software that currently has either vendor-supplied or third-party device drivers.

Monitors

As you upgrade your video board, you might consider upgrading your monitor as well. Many of today's systems are being sold with SVGA monitors and graphics boards that can produce a resolution of 1024 by 768. While that sounds great, there's an exception here.

The laws of physics aren't as easily broken as the laws of man. The number of pixels that are displayed on a monitor are limited by the size of the monitor.

To display a resolution of 1024 by 768 pixels on a 14-inch screen, the characters would be so small as to be nearly unreadable. If you want to display this resolution, you need to upgrade to at least a 16-inch or 17-inch monitor. If you buy a new monitor, however, you're going to be spending almost \$1,000 for the monitor alone. That's hardly an inexpensive upgrade, but it might be necessary for certain applications. The higher resolution is beneficial on a 14-inch monitor when you have software that creates variable-sized pixels for fonts or a graphics applications.

If you plan to upgrade your monitor from EGA, CGA, or monochrome, you should strongly consider a multifrequency monitor. Such monitors, which are sold by a large number of vendors, provide the most flexibility. As technology changes and graphics cards are able to generate signals at higher frequencies, these monitors

will be ready to translate that signal into an image.

Buying a multifrequency monitor is truly planning for the future. Multifrequency monitors are more expensive than standard SVGA—they start at approximately \$400—but they can grow with you better than any other monitor.

Warranty, Service, And Upgrades

All manufacturers offer at least a one-year warranty; many offer two years or more. Warranties are important, but even more important is the company standing behind the warranty. Make sure when you buy your video board that you know how to get warranty service.

As with most components, it's generally best to buy from a company with a recognizable name. Major board manufacturers such as ATI Technologies, Video Seven, Hercules Computer Technology, and Orchid Technology get much of their business from repeat customers. There's a reason for that: service.

Many of the companies now have bulletin board systems from which you can download the latest device drivers, software upgrades, and other information. In addition to the BBS, find out if the manufacturer has an 800 phone number for support, the cost of the support, and period of time that you get support.

Some vendors charge for support, either directly or via a 900 telephone number. From the user's perspective, free support is always preferred.

Whichever graphics upgrade you select, chances are you'll not only see the results immediately, but you'll find a whole new enjoyment in computing. There's nothing like crisp text, sharp graphics, and the elimination of eye strain to make computing a pleasure. ■

COMPARISON CHART: SUPER VGA GRAPHICS BOARDS

COMPARISON CHART: SUPER VGA GRAPHICS BOARDS

Make/Model	Length Of Card	Bus Compatibility	Auto. Mode Switching	Graphics Controller Manufacturer	Colors: Max.; Simultaneous	Non-Standard Board	Video RAM: Basic; Max.	Other Features	Works With	Price
Applied Data Systems VectorScan RISC	full-length	XT	—	VLSI	16 million; 16	N	1Mb; 8Mb	on-board display list RAM	IBM PC & compats.	\$575 (1Mb)/ 725 (4Mb)/ 995 (8Mb)
Artist Graphics WinSprint 100 Plus	half-length	ISA, EISA	Y	Texas Instruments	16.7 million; 32,000	N	1Mb; 1Mb	panoramic view, command center	IBM PC, AT, & compats.	\$595
WinSprint 200	full-length	ISA, EISA, MCA	Y	Texas Instruments	16.7 million; 256	N	1Mb; 1Mb	panoramic view, command center	IBM PC, AT, & compats.	995
Artist XJS Model 1280-16	full-length	EISA, ISA	Y	Texas Instruments	16.7 million; 16	N/A	1Mb; 1Mb	GT Display List AutoCad, Flexicon	IBM XT, AT, & compats.	2,995
Artist XJS Model 1024	full-length	EISA, ISA	Y	Texas Instruments	16.7 million; 256	N/A	1Mb; 1Mb	GT Display List AutoCad, Flexicon	IBM XT, AT, & compats.	2,995
Artist XJS Model 1280-256	full-length	EISA, ISA	Y	Texas Instruments	16.7 million; 256	N/A	1Mb; 2Mb	GT Display List AutoCad, Flexicon	IBM XT, AT, & compats.	3,495
AST Research AST-VGA Plus	half-length	XT, AT, ISA	N	—	262K; 256	—	256K; 512K		IBM PC, XT, AT, & compats.	\$329
ATI Technologies VGA BASIC-16	half-length	AT	—	ATI	16; 16	N	256K; 256K		IBM PC, AT, & compats.	\$89
VGA INTEGRA	half-length	AT	—	ATI	256; 256	N	512K; 512K	1024 X 768 resolution in 16 colors	IBM PC, AT, & compats.	119

All prices are U.S. suggested list. — = Information not available at press time. N/A = Not applicable

COMPARISON CHART: SUPER VGA GRAPHICS BOARDS

Make/Model	Length Of Card	Bus Compatibility	Auto. Mode Switching	Graphics Controller Manufacturer	Colors: Max.; Simultaneous	Non-Standard Board	Video RAM: Basic; Max.	Other Features	Works With	Price
VGA WONDER XL 512K	half-length	XT, AT, MCA	—	ATI	32,768; 32,768	N	512K; 512K	color depth enhancement offering virtual 24-bit color	IBM PC, AT, & compats.	179
GRAPHICS VANTAGE 512K	half-length	AT, MCA	—	ATI	256; 256	N	512K; 512K	Crystal Fonts	IBM PC, AT, & compats.	299
GRAPHICS VANTAGE 1Mb	half-length	AT, MCA	—	ATI	256; 256	N	1Mb; 1Mb	Crystal Fonts	IBM PC, AT, & compats.	349
8514/ULTRA 512K	full-length	AT, MCA	—	ATI	256; 256	N	512K; 512K	incl. MS-Mouse, high refresh rate	IBM PC, AT, & compats.	499
8514/ULTRA 1Mb	full-length	AT, MCA	—	ATI	256; 256	N	1Mb; 1Mb	incl. MS-Mouse, high refresh rate	IBM PC, AT, & compats.	599
GRAPHICS ULTRA 512K	half-length	AT, MCA	—	ATI	256; 256	N	512K; 512K	Crystal Fonts	IBM PC, AT, & compats.	599
GRAPHICS ULTRA 1Mb	half-length	AT, MCA	—	ATI	256; 256	N	1Mb; 1Mb	Crystal Fonts	IBM PC, AT, & compats.	699
Boca Research Boca VGA Plus	half-length	EISA, ISA	—	—	256; —	N	256K; 512K		IBM PC & compat.	\$119 (256K)/ 145 (512K)
Super VGA by Boca	full-length	AT	—	—	256; 16	N	1Mb; 1Mb		IBM AT & compats.	210
Boca SuperX VGA	half-length	XT, AT	—	—	256; 16	N	1Mb; 1Mb		IBM XT, AT, & compats.	235
Everex Viewpoint NI	half-length	AT	Y	Tseng Laboratories	256,000; 256	N	256K; 512K		IBM PC, XT, AT, & compats.	\$199 (256K)/ 219 (512K)

Make/Model	Length Of Card	Bus Compatibility	Auto. Mode Switching	Graphics Controller Manufacturer	Colors: Max.; Simultaneous	Non-Standard Board	Video RAM: Basic; Max.	Other Features	Works With	Price
Viewpoint Premium	.75-length	ISA	Y	Tseng Laboratories	256,000; 32,000	N	512K; 1Mb	72Hz refresh rate at 640 X 480	IBM PC, XT, AT, & compats.	299 (512K)/ 339 (1Mb)
Viewpoint TC	full-length	ISA	Y	Tseng Laboratories	16.8million; 16.8million	N	1Mb; 1Mb	displays 16.8 million colors at 640 X 480/ 512 X480	IBM PC, XT, AT, & compats.	795
Vision VGA	full-length	AT	Y	—	256; 256	Y	512K; 1Mb	VGA graphic overlay onto video signals	IBM XT, AT, & compats.	795 (512K)/ 895 (1Mb)
Focus Information										
Systems 2theMax VGA4000	—	XT, AT	Y	Tseng Laboratories	65,536; 65,536	N	1Mb; 1Mb	72Mz refresh rate	IBM PC & compats.	\$199
Hercules										
Graphics Station GOLD16	full-length	ISA	Y	Texas Instruments	32,768, 32,768	—	1Mb; 1Mb	VGA pass through TIGA support; opt. 2Mb DRAM	IBM AT & compats.	\$399
Graphics Station GOLD24	full-length	ISA	Y	Texas Instruments	16.7 million, 16.7 million	—	1Mb; 1Mb	VGA pass through TIGA support; opt. 2Mb DRAM	IBM AT & compats.	499
Graphics Station GOLD16+2	full-length	ISA	Y	Texas Instruments	32,768, 32,768	—	1Mb; 1Mb	VGA pass through, 2Mb DRAM, TIGA support	IBM AT & compats.	579
Graphics Station Card	full-length	ISA	Y	Texas Instruments	16.7 million, 16.7 million	—	1Mb; 1Mb	TIGA support; opt. 2Mb DRAM	IBM AT & compats.	599
Graphics Station GOLD24+2	full-length	ISA	Y	Texas Instruments	16.7 million, 16.7 million	—	1Mb; 1Mb	VGA pass through, 2Mb DRAM, TIGA support	IBM AT & compats.	679
Graphics Station MC	full-length	MCA	Y	Texas Instruments	16.7 million, 16.7 million	—	1Mb; 1Mb	VGA pass through, 1Mb DRAM, TIGA support; opt. up to 8Mb DRAM	IBM PS/2 Micro Channel	679

COMPARISON CHART: SUPER VGA GRAPHICS BOARDS

Make/Model	Length Of Card	Bus Compatibility	Auto. Mode Switching	Graphics Controller Manufacturer	Colors: Max.; Simultaneous	Non-Standard Board	Video RAM: Basic; Max.	Other Features	Works With	Price
Graphics Station+2	full-length	ISA	Y	Texas Instruments	16.7 million; 16.7 million	—	1Mb; 1Mb	2Mb DRAM, TIGA support	IBM AT & compats.	699
CHROME	full-length	ISA	Y	Texas Instruments	16.7 million; 16.7 million	—	3Mb; 3Mb	VGA pass through, 1Mb DRAM, TIGA support; opt. up to 40Mb DRAM	IBM AT & compats.	1,695
SUPERSTATION 3D Model GB820	full-length	ISA	Y	Texas Instruments	16.7 million; 16.7 million	—	2Mb; 2Mb	VGA pass through, 2Mb DRAM, TIGA support; opt. up to 16Mb DRAM	IBM AT & compats.	2,495
SUPERSTATION 3D Model GB960	full-length	ISA	Y	Texas Instruments	16.7 million; 16.7 million	—	2Mb; 2Mb	VGA pass through, 2Mb DRAM, TIGA support; opt. up to 16Mb DRAM	IBM AT & compats.	3,395
Micro Express Extended VGA Card	—	XT, AT	—	—	256; 256	N	1Mb; 1Mb	132-column text mode, vertical & horizontal panning/scrolling	IBM PC & compats.	\$170
Micro-Labs VGA Solution	.75-length	XT, AT, EISA, ISA	Y	Tseng Laboratories	262,000; 256	N	256K; 512K	VESA driver	IBM PC, XT, AT, & compats.	\$165 (256K)/ 179 (512K)
Ultimate VGA	half-length	XT, AT, EISA, ISA	Y	Tseng Laboratories	262,000; 256	N	512K; 1Mb	VESA driver, 8514A driver	IBM PC, XT, AT, & compats.	199 (512K)/ 225 (1Mb)
Ultimate VGA/HiColor	—	XT, AT	Y	Tseng Laboratories	32,000; —	N	1Mb; —	72Hz refresh rate	IBM PC, XT, AT, & compats.	265
Ultimate VGA+	half-length	XT, AT, EISA, ISA	Y	Tseng Laboratories	16.7 million; 786,000	N	1Mb; 1Mb	VESA driver, 8514A driver	IBM PC, XT, AT, & compats.	289

COMPARISON CHART: SUPER VGA GRAPHICS BOARDS

Make/Model	Length Of Card	Bus Compatibility	Auto. Mode Switching	Graphics Controller Manufacturer	Colors: Max.; Simultaneous	Non-Standard Board	Video RAM: Basic; Max.	Other Features	Works With	Price
Orchid Technology ProDesigner IIs	.75-length	XT, AT	Y	—	32,768; 32,768	N	512K; 1Mb	font editor	IBM PC, XT, AT, & compats.	199 (512K)/ 249 (1Mb)
Fahrenheit 1280	half-length	XT, AT, ISA	Y	—	16.8 million; 16.8 million	N	512K; 1Mb	24-bit color at 640 X 480	IBM XT, AT, & compats.	329 (512K)/ 399 (1Mb)
ProDesigner II/MC	full-length	MCA	Y	—	32,768; 32,768	Y	1Mb; 1Mb	full VESA mode compat.	IBM PS/2 & compats.	399
Sigma Designs Sigma VGA Legend	full-length	XT, AT	Y	—	256,000; —	N	512K; 1Mb	selectable screen refresh rates up to 85Hz	IBM PC, XT, AT, & compats.	\$299 (512K)/ 359 (1Mb)
Sigma VGA Legend II	full-length	XT, AT	Y	—	32,000; —	N	512K; 1Mb	selectable screen refresh rates up to 88Hz	IBM PC, XT, AT, & compats.	399
STB Systems WIND/X HC	half-length	—	—	—	32,000; —	N	512K; 1Mb	application drivers: Windows 3.1, SCO Unix, OS/2 PM	IBM PC, XT, AT, & compats.	—
MACH-512	half-length	XT, XT	Y	—	256; —	N	256K; 512K	72Hz vertical refresh rates	IBM PC, XT, AT, & compats.	—
A1-VGA	half-length	XT, XT	Y	—	256; —	N	256K; —		IBM PC, XT, AT, & compats.	—
Video Seven VRAM II Ergo	—	XT, AT	—	—	256; 256	N	1Mb; 1Mb	VESA support, true 16-bit throughput	IBM AT & compats.	399
SPEA 1280	full-length	AT	—	Texas Instruments	256; 256	—	2Mb; —	refresh rates up to 84Hz	—	1,999

COMPARISON CHART: SUPER VGA GRAPHICS BOARDS

Make/Model	Length Of Card	Bus Compatibility	Auto. Mode Switching	Graphics Controller Manufacturer	Colors: Max.; Simultaneous	Non-Standard Board	Video RAM: Basic; Max.	Other Features	Works With	Price
Wyse WY-451	half-length length	XT, AT	N	—	256,000; 256	N	256K; 256K	incl. drivers for 132-column text mode	IBM PC, XT, AT & compats.	\$85
WY-470	.75-length	XT, AT	N	Tseng Laboratories	256,000; 256	N	512K; 1Mb		IBM PC, XT, AT & compats.	339
WY-7500	full-length	XT, AT, ISA	N	—	N/A	Y	1Mb; 1Mb	designed for WY-790N monitor, mono. display	IBM PC, XT, AT, & compats.	699

GRAPHICS BOARD MANUFACTURERS

Applied Data Systems 409A E. Preston St., Baltimore, MD 21202, (301) 576-0335	ATI Technologies Inc. 3761 Victoria Park Ave., Scarborough, Ontario, CN M1W 3S2, (416) 756-0718	Everex Systems, Inc. 48431 Milmont Dr., Fremont, CA 94538, (800) 821-0806, (510) 498-1111	Hercules Computer Technology Inc. 921 Parker St., Berkeley, CA 94710, (415) 540-6000	Sigma Designs Inc. 47900 Bayside Pkwy., Fremont, CA 94538, (510) 770-0100
Artist Graphics 2675 Patton Rd., St. Paul, MN 55113, (612) 631-7800; (800) 627-8478	Boca Research, Inc. 6413 Congress Ave., Boca Raton, FL 33487, (407) 997-6227	Focus Information Systems, Inc. 4046 Clipper Ct., Fremont, CA 94538, (510) 657-2845	Micro Express 1801 Carnegie Ave., Santa Ana, CA 92705, (714) 852-1400	STB Systems, Inc. 1651 N. Glendale, Ste. 210, Richardson, TX 75801, (214) 234-8750
AST Research, Inc. 16215 Alton Pkwy., P.O. Box 19658, Irvine, CA 92713, (714) 727-4141	CompuAdd Corp. 12303 Technology Blvd., Austin, TX 78727, (800) 627-1967, (800) 456-3116	Headland Computer Technology, 46221 Landing Pkwy., Fremont, CA 94538, (415) 656-7800	Micro-Labs Inc. 7309 Campbell Rd., Dallas, TX 75248, (214) 702-8654	Wyse Technology 3471 N. First St., San Jose, CA 95134, (408) 473-1200, (800) GET-WYSE
			Orchid Technology 45365 Northport Loop W., Fremont, CA 94538, (510) 490-8586	

Hard Cards

Are you running out of space on your hard drive? If so, perhaps one of these popular hard cards will meet your needs.

If you need a quick and easy way to add 40-100Mb of hard disk storage to your computer, but you've already filled all of your system's hard drive bays, consider a hard card: a hard drive and controller mounted on a standard expansion card. For this section we reviewed three of the more popular hard cards for size, speed, installation, cost, documentation, and technical support.

What makes a hard card unique is the ease with which it can be installed and moved from system to system. Installation consists simply of opening the computer case, pressing the hard card into a standard expansion slot, securing the card with a screw, and closing the case. To remove the card, open the case, unscrew the card, and pull it out of the slot. Even the most timid computer owners will find this procedure simple. Some hard cards require starting your system with a special boot disk and installing the disk manager software that comes with the card.

By contrast, installing a fixed hard drive can be a lengthy process. Many hard drives require mounting brack-

ets, which you have to attach prior to installation. With some drives, you have to establish the address and type of hard drive through your computer's BIOS, and some of the older BIOS chips don't recognize some of today's newer hard drives. Finally, you usually have to format your fixed hard drive when installation is complete. In our tests only the HDI card needed to be formatted, since the other cards came preformatted from the manufacturer.

Who Uses a Hard Card?

Some people use hard cards when they have no other available hard drive bays. Other people use them instead of a removable hard drive: Once you back up data to the hard card, it's easy to remove the card and install it in another computer. You can protect sensitive data by removing the hard card at the end of every day and placing it in a secure location like a safe or locked room, or taking the card home with you.

Like a fixed hard drive, a hard card is assigned its own drive letter by

your system. The data access rate—the time it takes the read/write head to reach a given sector on the drive—is usually comparable to that of a fixed hard drive. For example, the Plus Hardcard II XL drive—one of the fastest hard cards on the market—has an effective access time of 9 milliseconds (ms), the CMS 245.36Mb hard card has an access rate of 12ms, and the HDI 105 Card Drive has an access rate of 15ms. These figures are equivalent to Conner and Maxtor drives of similar size, which have access speeds of between 14-19ms.

Depending on how thick it is, a hard card can take up to two card slots or require installation in an end slot. All of the cards we tested were able to fit into a single card slot.

Cost

Prices for hard cards have fallen dramatically over the last year, making them very competitive with fixed hard drives. For example the Plus Hardcard II XL 105Mb from Quantum has a suggested retail price of

\$569, Hard Drives International's 105Mb card (XT version) is priced at \$459, and the CMS 245.36Mb hard card is priced at \$1,199. Equivalent fixed drives sell for about \$450 for 120Mb and \$750 for 200Mb. When determining whether a particular hard card will fit your needs, you should also consider other factors like speed, ease of installation, IDE conflicts, sturdy construction, and company technical support.

Testing Conditions

We reviewed hard cards from Hard Drives International, CMS, and Plus Hardcard. Each drive was evaluated on the basis of performance and ease of installation. The test computers were a 286 running at 16 MHz and a 386 and i486 running at 33 MHz.

The drives from CMS and HDI have an IDE controller on the card, and will not run as long as another IDE controller is present in the computer. Our testing systems had existing IDE controllers installed, and locked up without an error message during installation of the CMS and HDI hard cards. We then tried to install these hard cards in systems where IDE drives were present but switched off, and the systems locked up again. We finally succeeded when we replaced existing system controllers with a single 8-bit floppy-only controller. You can pick up a floppy-only controller card for about \$50 at most computer hardware stores.

REVIEWS

HDI Card Drive 105

The HDI 105 is a Seagate ST3120A hard drive connected to an 8-bit IDE controller and mounted on a full-length expansion card. It provides 105Mb of storage space in IDE for-

mat and includes a hard disk manager and checker, plus the information needed for installation.

HDI offers hard cards in 20, 30, 40, 50, 80, and 105Mb configurations.

The cards differ not only in storage size but in disk manufacturer. For example, the 40Mb card is a Conner Peripherals disk, the 80Mb is a Maxtor disk, and the 105Mb is by Seagate.

Hard Cards vs. Hard Drives:

Comparisons of Access Time, Performance Speed, and Cost between Hard Cards tested and comparable popular standard hard drives.

Access Rates*

Hard Cards		Hard Drives	
HDI 105 Card Drive	15ms	Maxtor and Conner 120Mb IDE	15ms
CMS 245.36	12ms	Maxtor and Conner 200Mb IDE	14ms
Plus Hardcard II XL (105Mb)	9ms		

* Access rate is the time in which the drive's read/write head can reach a given sector on the drive, in milliseconds.

Performance Speed Test Results

Processing speeds recorded for 200 files written to the cards listed and to the listed hard drives; the 200 files then deleted and the processing speed recorded.

Device	Write Speed (in secs.)	Delete Speed (in secs.)
Hard Cards		
CMS	19 sec.	15 sec.
HDI	20 sec.	13 sec.
Plus Hardcard II XL	24 sec.	20 sec.
Hard Drives		
Maxtor 130Mb IDE	20 sec.	14 sec.
Conner 120Mb IDE	26 sec.	15 sec.

Cost Comparison

Hard Cards		Hard Drives	
HDI 105 Card Drive	\$459(XT), \$499(AT)	Maxtor 120Mb IDE	\$450
		Conner 120Mb IDE	\$435
Plus Hardcard XL II	\$569	Conner/Maxtor 200Mb IDE	\$750
CMS 245.36	\$1,199		

The drive comes unformatted from HDI; you format the disk using the disk manager software. Before using this software, you need to install your DOS system on a floppy disk using the `FORMAT /s` command, then reboot your computer with the boot floppy disk in drive A. Once the system is up again, you must replace your boot disk with the disk manager software floppy and copy the necessary hard drive installation programs to the hard card. After performing this installation, you will be able to boot your system from the hard card.

On most AT computers, you will need to set the BIOS to "No Hard Drive." To change the hard drive configuration in your BIOS, enter `CTRL+ALT+DEL` to do a warm boot. Immediately after initiating the warm boot, press the `DEL` key, which will call up the BIOS Management Tool.

Toggle through the hard drive selection menu until it reads "No Hard Drive" and save the new BIOS configuration by pressing the `ESC` key. After you have changed the BIOS, the computer will warm boot and accept the new BIOS instructions.

Since this drive will not run with another IDE controller in the system, we had to remove the existing IDE controller from the test unit and replace it with a floppy-only controller. Fortunately, the manual warned us of this potential conflict, making identifying and solving the problem easy.

The only problems encountered with this card were its 8-bit IDE controller and an extra length of metal that sticks down below the card when you install it on the motherboard. This hard card frame could conflict with extended memory or other hardware objects commonly located near the front of many

motherboards. On the positive side, the hard card runs as well as most fixed IDE hard drives we've used, and HDI's customer service department handled our test call quickly and effectively.

Documentation Rating: Adequate The installation instructions were printed on a single sheet of paper accompanying the user's manual, and were clear and concise. Installation was quick, consisting simply of plugging the card into a slot on the motherboard and running the disk manager software. The Troubleshooting section of the manual consisted of switch settings for addressing the card.

Technical Support Rating: Excellent An 800 number is provided for technical support. Our test call took only three minutes from start to finish. The support staff picked up the phone in two to three rings and was knowledgeable and informative.

CMS 245.36Mb

For our test, CMS provided a custom 16-bit hard card with an impressive 245.36Mb Seagate drive.

Even though no documentation was provided for this custom card, installation was surprisingly straightforward once the company's technical support faxed us information on switch settings. Like the HDI hard card, the CMS has to be the only IDE controller in the system, and our test computer locked up during installation. After replacing the test system's IDE controller with a floppy-only controller, we were able to bring up the preformatted drive by setting the BIOS hard drive settings to "No Hard Drive" and booting up with the drive.

The case is a simple box frame, which adds strength and solidity to the drive unit. In addition, the card has rubber feet that rest on the chip

set on the motherboard—a clever way of keeping metal from touching metal within the computer.

We did run into a few problems, however. First of all, the Seagate Model ST3283A drive was quite noisy when it was accessing data. Our 386 and i486 motherboards had memory chips and jumpers located near the front, so we had problems seating the card. We were eventually able to install the card after testing every slot to find one that would seat the card properly. While we were able to install the card with our present memory configuration, we realized that if all of our memory slots had been filled, we would have not been able to install the hard card without having to remove some memory chips. At this time, the company doesn't plan to correct this problem.

Documentation Rating: N/A Since this was a custom drive, the normal documentation was not included. Therefore, the documentation can't be rated. However, we were able to install the card without the instructions. The company informed us that documentation was being printed at the time of our review.

Technical Support Rating: Adequate Technical Support is available through the company's central phone number, which is not toll-free. Technical support answered the phone in two or three rings, but we were put on hold frequently. Since this was a custom card, the Tech Support staff was unfamiliar with its configuration needs, and took about 5-10 minutes to answer our test question. We felt that tech support was trying to be helpful, but needed improvement.

Quantum's Plus Hardcard II XL

The Plus Hardcard II XL from Quantum, available in 52Mb and 105Mb versions, shows forethought and insight on the part of its designers. The card includes a well-written manual, drivers, and a list of items you should find in the box. Its greatest benefit is that the card doesn't conflict with the hard drive disk controller you currently have installed in your computer. The Hardcard II XL ran our tests without any problems despite two existing IDE controllers in our system.

Of the cards tested, the Hardcard II XL is the easiest to install. All you have to do is add a driver line to your CONFIG.SYS file and run a small Install program. Since it doesn't conflict with other controllers, it's also the most flexible card for users that want to swap it from one system to

another. The Hardcard II XL fit easily into an expansion slot and ran effortlessly with our existing drives.

Another feature found on the Hardcard II XL is a 64K on-board firmware cache that gives the card an effective access rate of 9ms—faster than many of the fastest fixed hard drives.

One of the strongest features of the Hardcard II XL is that it lets you install multiple Quantum cards without altering your system requirements. Since the Hardcard II XL doesn't conflict with other IDE-based hard drives, your 286, 386 or i486-based computer can contain hundreds of megabytes of storage space with the convenience of a simple plug-in-and-go hard card.

Hardcard II XL drives are compatible with 286, 386, and i486 comput-

ers with most operating systems and environments, including DOS, Novell NetWare, Microsoft *Windows*, and OS/2.

Documentation Rating: Excellent Instructions were step-by-step and extremely clear. A very comprehensive troubleshooting section was provided, but we didn't need it because installation was so easy. The manual is virtually dispensable once the card is installed.

Technical Support Rating: Good A 900 number is provided for Technical Support, with a surprising \$5 per call charge, regardless of the duration. We were on hold for 2-3 minutes before our call was taken. The Technical Support staff understood the problem and was able to solve it on the phone in less than five minutes.

Summary

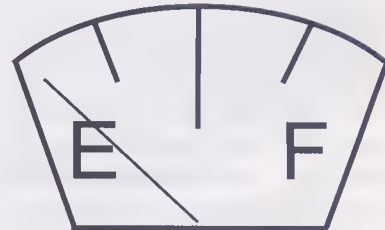
Each of the hard cards tested had noteworthy strengths. The HDI Card Drive 105 comes in a wide variety of storage sizes at a reasonable cost with the best technical support. The CMS custom hard card was well built and had a rugged design, plus the largest storage space of those tested. The Hardcard II XL was the easiest to install and was the most flexible for working with an already-installed hard drive.

If your hard drive and drive bays are full, or you'd like the convenience of an essentially removable hard drive, then a hard card makes sense. With competitive prices, comparable speeds, and ease of installation, hard cards have more to offer now than ever before. ■

Products Featured

Product	Company
HDI Card Drive 105	Hard Drives International 1912 West Fourth Street Tempe, AZ 85281 (800) 488-0001
CMS 245.36Mb	CMS Enhancements 2722 Michelson Irvine, CA 92715 (714) 222-6646
Plus Hardcard II XL	Quantum 500 McCarthy Boulevard Milpitas, CA 95035 (800) 624-5545

Laser Toner Cartridge Refills



If you're a steady user of lasers you can bring down the per page cost of your printing by having your old laser cartridge refurbished rather than buying a new one every time. There's two other pluses as well. You'll be able to output more pages before the next refill and you won't add to the deterioration of the environment.

Imagine a hill hundreds of feet tall and many acres wide, filled with plastic and other non-recyclable or toxic materials. Now put a tall, strong fence around it for 100,000 years, to keep out flora, fauna, and humans. That is the amount of waste generated by the more than 20 million laser toner cartridges currently being discarded annually.

Like disposable diapers and plastic soda bottles, used laser cartridges are one of those pesky, but seemingly unavoidable environmental atrocities. Or are they? The next generation of non-impact printers may partially or even completely eliminate cartridges, but that's still months or years in the future. In the meantime, you can be kind to the planet, save money, and maybe even get a higher quality printout by extending the life of your current Hewlett-Packard and Canon laser printer cartridges by recycling them via a method called

remanufacturing.

A new Hewlett-Packard SX-type laser toner cartridge for the Series II and III LaserJet printers has a list price of \$125, and a street price of between \$75 and \$105. (While we're focusing primarily on the ubiquitous Hewlett-Packard/Canon SX cartridges in this article, much of the same information is applicable to IBM, Ricoh, and other types of cartridges.) Most laser printer owners use a cartridge until the toner is virtually depleted and the type or image appears too light on the paper; then they throw it away and put in another, new unit. Having a disposable laser toner cartridge is quick and convenient, but it's also expensive and wasteful.

Originally, Canon designed all its cartridges as single use disposable items. But not long after the first generation of desktop laser printers hit the market in the mid-80s, a hand-

ful of cost conscious technical types discovered that they could often extend the useful life of the cartridge by a factor of two or three—and eventually 12 or more times—at a cost significantly lower than the price of a new unit. How? It turned out that while the toner in the cartridge became exhausted, the light-sensitive OPC (Organic Photoconductor) drum could still be used for many additional pages.

That's the core of what eventually evolved into a multi-hundred million dollar industry: remanufacturing laser cartridges.

What Is Cartridge Remanufacturing?

Remanufacturing is a sophisticated, multi-step process that turns exhausted cartridges into as-good-as-new or even better-than-new condition, at the cost of roughly half to

two-thirds of a new unit. The cartridge is disassembled; the recovered spent toner is discarded and all parts are thoroughly cleaned; worn parts are refurbished or replaced; the drum is polished, or chemically treated to extend its life, or replaced; it's then filled with fresh toner, reassembled, sealed and tested; a new felt wand is provided; and finally, it's shipped back to the owner.

There are hundreds of companies that specialize in remanufacturing laser cartridges. If the quality and the type of service they offer were identical, it would be a very easy matter to select a remanufacturer solely upon price and convenience. However, there are a number of subtle and significant variables that hinder easy comparison. Read on, and we'll tell you everything that you should know about remanufacturing.

My Cartridge Or Your Cartridge?

Most national remanufacturers require that you send them your depleted cartridge and felt wand in good condition, preferably in the original carton. The general rule of thumb is that you pay to ship it to them. The return shipping cost is included in their price. (There are exceptions, however.)

Incidentally, many local or regional companies provide a free pickup and delivery service to customers within a certain radius. Although most companies will rebuild your own cartridge, others simply swap it for an already remanufactured unit that someone else sent in earlier. There are two schools of thought about this use-my-own or send-and-swap approaches. By having them remanufacture your own cartridge, you can be reasonably sure that you won't get someone else's lemon, or a unit with a drum that's close to its

expiration limit. On the other hand, rebuilding a cartridge involves, on average, a 24-to-72 hour turnaround, so it may be longer before you get it back. A swapped unit can be filled immediately from existing stock. It might also be better than your own cartridge.

If you don't have a cartridge, or if it's damaged and therefore not reusable, don't worry. Most companies sell refurbished cartridges for \$10-\$15 above the going rate for remanufacturing your cartridge.

How Much Is Enough Toner?

A standard, off-the-shelf, new Canon/Hewlett-Packard SX-type laser cartridge contains exactly 200 grams of its own brand medium-grain toner, or, enough toner to print, on average, 3,000-4,000 pages of double-spaced text. (That's assuming a 6% density—meaning, only 6% of the surface of the paper is covered with toner. The exact number depends on the density setting you use, the typeface, etc. Graphics images and desktop publishing applications, however, routinely use much more toner than text—25%-40% densities are common—meaning that you might only be able to print a few hundred pages before the cartridge is empty.)

Most remanufacturers refill SX cartridges with at least 225 grams of generic toner (generic or third-party toner is considered superior to Canon's toner), which supposedly provides an extra 10%-25% of printing. Believing that more is better, some remanufacturers boast that they add 250g, 275g, or even 300g of toner. Whether or not additional toner will boost output is a matter of considerable controversy. As a practical matter, squeezing in more than 225g in a standard SX cartridge could conceivably compress and compact some of

the toner. While it won't damage your printer or significantly affect print quality, toner compression may effectively cancel out any gains in extending the number of pages that can be printed.

However, some companies, in addition to remanufacturing standard SX cartridges, produce their own, slightly larger cartridge—modestly called super cartridges—that can accommodate 300g of toner, with virtually no threat of compression. Then, it's possible to get 5,000 or more pages from one reload.

Typically, there are three grades of toner that you can order: coarse, medium, and fine grain. Toner is nothing more than tiny iron filings that are fused onto paper by a heating element in the laser printer. The size of the filings, however, can be critical. Most cartridges are filled with a medium grain toner, the best choice for text and occasional graphics use. Coarse grain toner is blacker, and is more suited for graphics applications. Fine and ultra-fine grain toner is more powdery, but leaves less residue. It is used primarily by the latest generation laser printers that produce high resolution images of 400x400, 600x600, or even 1,200x1,200 dots per inch (dpi). Most remanufacturers charge more for coarse and ultra-fine grain toners.

Many remanufacturers also offer colored toner for \$15-\$20 extra. Blue, brown, yellow, green, and red are common colors. A handful of companies also offer silver and gold. (Avoid the red, however, since it tends to turn rusty orange rather than a true red.)

Another type of toner offered for extra money is MICR (Magnetic Ink Character Recognition), which can be scanned by high-speed magnetic readers. MICR is used primarily to print payroll or corporate checks with imbedded account codes.

Replace Or Refurbish?

The most important part of the toner cartridge is the OPC drum. Canon's CX and SX-type drums are, theoretically, good for 8,000-12,000 prints, or 2-3 remanufacturing cycles. Most remanufacturers' basic service includes inspection and cleaning of the original drum. This should be all that's necessary. Unfortunately, for no discernable reason, many original equipment drums barely live through their first life cycle. In addition, they're very soft and susceptible to scratches and nicks that leave a distracting impression on every printed page. That's why even the best remanufacturing services discourage users from refilling a cartridge more than twice—unless something is done to improve or replace the drum. In fact, some remanufacturers are so negative about Canon's OPC drum that they advise discarding the original drum the first time the cartridge is sent in for service. In fact, several companies routinely discard any OPC drum they find and automatically replace it with a generic as part of their regular service.

Some services will, for free or for a nominal sum (\$5-\$10), coat a drum with a substance that supposedly extends its life while hardening it against scratches. Whether or not this really works is questionable: Some swear by it, while others swear at it. The only way to find out is to try it.

Because of the aforementioned problems, most remanufacturers strongly suggest replacing your original drum after two or three cycles. A new OPC drum usually costs about \$15. Given a choice between selecting a direct replacement from Canon, or a generic equivalent, opt for the latter. Most users report that generic drums produce a higher quality print and last longer.

Increasingly, most manufacturers

try to persuade customers to upgrade to premium long-life drums. Costing between \$30 and \$45 each, these drums are often guaranteed for 10, 12, or even more recharge cycles.

What Sort Of Guarantees Should You Get?

Of course, most remanufacturers guarantee their work against defects and poor print quality. If you aren't satisfied with the results, you can usually get a refund, an exchange, or another rebuild. But the guarantee that you should really be concerned with is if the manufacturer will agree to compensate you for any damage to your laser printer caused by a faulty cartridge.

Hewlett-Packard, Canon, and other laser printer manufacturers will not honor your warranty if the printer has been damaged because of a remanufactured cartridge. However, most, but not all, remanufacturers

promise to pay to repair or replace your printer if you can prove that they caused the problem. Make certain that you get that guarantee in writing. If a company isn't willing to give it to you, perhaps it's time to take your business to another remanufacturer.

Fill-It-Yourself Super Cartridges

Several remanufacturers have developed a product for companies that want to recycle their printer toner cartridges, but don't want to be bothered shipping them back or waiting days for them to be returned. It's a modified super cartridge with oversized plugs that can be safely and easily drained and refilled. The parts that ordinarily need cleaning or replacing are constructed so they may go through a certain number of refills without suffering any ill effects. Depending upon the manufacturer, they may be recharged a total of four



You may not read about laser toner cartridge remanufacturers in *Entrepreneur* magazine, but such companies (like J R Laser Technologies, Inc., shown here) are in the midst of a multi-billion dollar boom.

The ICRA

If you wish to contact a local remanufacturing company, call the International Cartridge Recycling Association, a 600-member trade organization. The ICRA will be happy to provide you with the names of remanufacturers that do business in your area.

Call (202) 857-1154.

to six times before wearing out. Although a bottle of toner costs only \$10-\$15, there's no real dollar savings because the initial cost of these supercartridges is quite high (\$160 to \$175). But the advantage is that you can do your own recharging in minutes, rather than waiting for days.

Extending The Life Of Your Cartridge

Here are a few things you can do to stretch the number of pages that you print, as well as extend the useful life of your cartridge:

- Turn down the darkness wheel inside your laser printer. Your pages print slightly lighter, but you will probably get more of them.
- Clean your laser printer's cartridge and print path occasionally with one of the commercially available sheets soaked with alcohol and solvents. It helps cut down toner build up, so you can turn the darkness wheel down and still get the same intensity of print.
- Clean (regularly) your printer's corona wires, and either use an air canister or a vacuum cleaner to remove dust that might eventually work its way into your cartridges.
- Take your cartridge out (occasionally) and gently rock it from side to

side. This helps prevent clumping.

- Store fresh cartridges in a cool, dry area. Heat and moisture can fuse the toner together in clumps large enough to damage your printer or cause it not to print at all.
- Put dates on your cartridges, both new and remanufactured, and use the oldest first.
- Save all the original packing, because that's the best way to ship cartridges without damage.
- Don't try to stretch a cartridge's useful life too far. Inspect the cartridges each time they are remanufactured for wear, fatigue, nicks in the plastic, etc. Then, when it's time, either trade it in to your remanufacturer for credit or send it back to Canon or Hewlett-Packard for final recycling.

Proper Disposal Of Old Cartridges

Incidentally, even if you don't want to use remanufactured cartridges but insist on new ones every time, most companies will pay you \$5-\$10 for your used cartridges. Recently, HP and Canon have begun including a prepaid mailer in every new cartridge box. Instead of discarding the used cartridge, you mail it back to the company, and they'll recycle the

metal parts and toner, grind up, melt, and reuse the plastic to make new cartridge cases. They won't give you any cash refund, but you'll have the satisfaction of knowing that your empty cartridge won't end up in a landfill somewhere.

What About The "Drill And Fill" Method?

Before remanufacturing, there was the "drill and fill" method for reusing toner cartridges. Drill and fill is exactly like it sounds. A small hole is drilled in the bottom of the plastic cartridge, the exhausted toner is allowed to pour out, and then the hole is plugged up with tape. A second hole is drilled on the top, into which a bottle of fresh toner is dumped. Then, that hole is plugged up too. Theoretically, the cartridge is now good for a few thousand pages, and could be successfully refilled at least one more time before the OPC drum loses its charge.

On the plus side, drill and fill cartridge refilling is relatively inexpensive. Do-it-yourselfers who are handy and not afraid of getting their hands dirty (It can be a messy process.) can buy kits and bottles of toner from a number of suppliers and distributors for as little as \$8-\$10 per charge. There are also many commercial services that will fill your cartridge and replace the felt wand, at an average cost of between \$15 and \$35.

However, there are so many minuses to the drill and fill method that we strongly advise against it. Since fill and drill doesn't involve disassembly of the cartridge, there's no way that it can be completely cleaned of spent toner, or that worn parts can be repaired or replaced. By forcing toner down a small hole, it often compacts and clumps, thus rendering much of it useless. Furthermore, clumped toner tends to scratch the

CARTRIDGE REMANUFACTURERS

Here's a list of cartridge remanufacturers you can contact

Advantage Laser Products 1929 Quenn City Avenue Tuscaloosa, AL 35401, 800-239-4027. \$45.00 per cartridge which includes cleaning and replacement of any broken or worn parts free, shipping included.

Black Lighting; RR 1 Box 87; Hartland, VT 05048; (800) 252-2599; \$59.99 standard, \$69.99 for graphic (darker grade); includes return shipping; 24-48 hour turnaround; fills with 250g; includes polish; additional cost for OEM replacement drum \$9.00, \$34.95 for long-life drum; \$89.99 for color drum; \$79.99 for transfer (for T-shirts).

CAL Toner 10923 Randall St. Unit A, Sun Valley, CA 91352 (800) 966-8738; \$29 per cartridge, drum replacement additional, return shipping included.

Cardinal Cartridge & Supplies; 2833 Old Higgins Road; Elk Grove Village, IL 60007; (800) 225-8672; \$59; includes return shipping; 24-hour turnaround; fills with 250g; replace OPC drum with long-life Turbo for no additional cost; color and MCIR toners, \$20-\$25 more.

Chenesco Products; 62 North Coleman Road; Centereach, NY 11720; (800) 221-3516; \$44.95, shipping extra; 24-48 hour turnaround; fills with 250g; treats drum with long-life substance; \$32.95 for long-life drum replacement; super cartridge with new drum \$79.95; colors \$15 additional; MICR toner for \$15 additional; no extra charge for fine-grain.

Chenesor Products 2221 Fifth Avenue Ste. 4 Ronkonkoma, NY 11779 516-467-3205. \$44.95 per cartridge refill which includes cleaning and examination, fully garenteed for 1 year, new drum cost is \$32.95, and used is \$12.00. Cartridges returned within 48 hours, and same day 24 hour service available.

Discount Laser Supply 203 Wildmere Dr. South Bend, IN 46615. 800-786-2270. \$39.95 per cartridge, all changes included in price, shipping paid for only on return of package, visa and mastercard accepted.

Eagle Business Machines 72 N. Saw Mill River Rd., Elmsford, NY 10523, 914-592-4946 Total cost for cartridge \$49.95, drum replacement in-cluded, shipping, no additional cost.

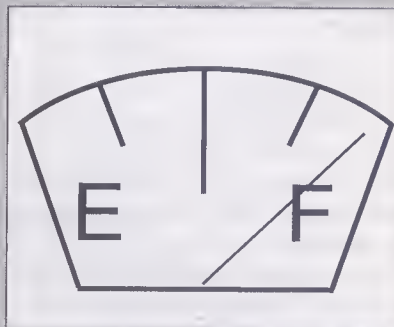
Innovative Scientific Concepts 2356 Winter Woods Blvd., Winterpark, FL 32792 407-657-7758. First time buyers, \$75 which includes replacement of drums to Long Life Drums, 2nd refill \$45 no replacement, shipping and handling included in all.

JR Laser Technologies, LTD PO Box 865 Mahopac, NY 10541, 800-866-3791. Price depends on size of cartridge but, 90% of cartridges are \$42, New York residents pay NY State sales tax, Shipping unless you live in NY is not included for delivery to Co., but Co. will UPS package back to you.

Laser Charge 11130 Metric Blvd. Austin, TX 78758, 800-299-8134. \$49.00 per cartridge, next day service available in local areas, return UPS shipping included.

Laser Renew of CT 55 Carmen Hill Rd., New Milford, CT 06776-4509, 800-347-4221 \$44 per cartridge with exchange, \$55 without exchange, no additional charge for shipping, additional charge if you want a super drum ther is an additional charge.

Laser's Edge, Inc.; 201 S. 23rd Street; Fairfield, IA 52556; (800) 635-8088; \$49; includes return shipping; 2-3 day turnaround; fills with 250g for regular, 300g for jumbo; \$13.33 extra for jumbo cartridge; \$30 extra for long-life drum.



Lasertone Inc. 1826 Myrtle Avenue El Paso, TX 79901, 800-333-7571. \$69.95 per cartiridge which includes a new super toner cartridge in place of your cartridge, also included is a long life optical drum, return shipping included. Volume discounts available.

Mid West Stationers 908 Broadway Marysville, KS 66508 800-562-2245. \$39 per cartridge, prices may vary according to quantity and model, shipping inbluded, drums are an additional cost.

National Toner Supply 800 Summer Street Stamford, CT 06901 800-676-0749. \$45 per cartridge, pick-up and delivery included, 10% discount on first cartridge, 10th cartridge free, drum replacement additional.

Pacific Toner Service 4010 Foot-hill Blvd., Ste. 113 Roseville, CA 95678 800-545-4579. \$36.95 per cartridge, shipping not included, drum replacement extra.

(Cartridge Remanufacturers Listing continued on next page)

soft and sensitive OPC drum. These problems and deficiencies frequently produce streaks, blots, blurs, or scratches on every printed page, so the print quality is terrible. Worse yet, the seals over the holes occasionally rupture. This leaking toner could seriously damage or even destroy a laser printer.

So notorious and unreliable has the drill and fill method been from the very beginning that it has given rise to several rumors that still live on today. One rumor was that Canon secretly put in "killer" toner particles that deliberately damage the drum, thereby making quality recharging impractical. The other was that using a refilled cartridge will void your warranty and could even destroy your printer. Neither myth is true, although it's easy to understand why many people would believe the killer toner theory because of the poor quality that drill and fill recharged cartridges produced.

Legally, using a refilled or even a remanufactured cartridge won't void your laser printer warranty, unless any damage done to the printer is a direct result of using a faulty cartridge.

Incidentally, don't confuse drill and fill with a variety of the so-called super cartridge kits that some companies sell. These particular super cartridges are specially designed units that come with built-in plugs, safe sealers, long-life drums, and bottles of toner. They are designed to be easily refilled, without mess, and without having to replace parts or clean out the cartridge.

The Remanufacturer That's Right For You

A rough estimate is that there are more than 600 national firms that specialize in remanufacturing and a countless number of local companies

that offer it with other services. You can see their ads in computer magazines and even general business publications. The general rule of thumb is that you are responsible for sending the cartridge to them; they pay the return shipping. (There are exceptions, however.) Locally, many companies advertise in the Yellow Pages under Computer Repair, Supplies, or Services. One advantage of using someone local is that many local companies offer free door-to-door pickup and delivery. Although it's probably convenient, we advise against using your local computer store. Most simply mark the price up significantly and send the cartridge out to a third-party remanufacturer. Or if the store remanufactures it themselves, they might not have the volume and therefore the experience or the expertise to do a good job consistently.

The most practical approach to selecting a regular remanufacturer is to send a single cartridge to them, and then evaluate the results. Did they return it promptly? Is the box and packing material in good enough condition to be used again? Did they include a new felt wand and an instruction sheet? Did they send you a written guarantee, both for the cartridge and against possible damage to your laser printer? Does the cartridge appear to be completely sealed, or is there a residue of toner somewhere that might indicate a sloppy job? Do pages come out clean, crisp, and dark? Does it leave scratches or smudges that indicate a damaged drum? Keep count: How many copies do you get before the cartridge is exhausted? If you are not satisfied with the quality or the service, take your business elsewhere.

Incidentally, once you have settled on a particular company, ask about volume discounts.

So Who Uses Remanufactured

Cartridge Remanufacturers Listing

(continued from preceding page)

Printworx; 3322 South Memorial Parkway; Huntsville, AL 35801; (800) 777-9679; \$49 for standard, \$59 for premium cartridge; shipping extra; same day service; fills with 250g; everything done on an exchange basis; \$30 for long-life drum; additional charge of \$20 for color and MICR toner; graphics quality (coarse) toner; all drums coated.

Repeat-O-Type Manufacturing Corp. 665 State Hwy. 23 Wayne, NJ 07470, 201-696-3330. Motified cartridge retails for \$79.95 4 cartridges included, color refills \$24.95, shipping and handling included.

SAS Industries; 3091 N. Bay Drive; North Bend, OR 97459; (800) 245-4657; \$55; 24-hour turnaround; includes return shipping; fills with 225g; \$30 extra for long-life replacement drum; doesn't cover damage to printer.

Southern Cartridge Service, Inc. 33 Matthews Drive Hilton Head Island, SC 29926, 800-442-6288. \$42.00 per cartridge refill, return UPS shipping included.

The Computer Link 3313 Elizabeth Avenue Wilmington, DE 19808, 800-366-6614. Recharge prices per cartridge are \$45.00, UPS shipping is not included, Visa & Mastercard accepted.

The Laser Group 223 Palmer Court DeKalb, IL 60115 800-527-3712. \$34.95 \$3 shipping, upgrade drum \$25 rechargeable in-definitely. □

Cartridges, anyway? Customers like most of the Fortune 500 companies, many major universities like Harvard, and public institutions like every department of the State of California, that's who. ■

Selecting The Right Modem

PC Upgrade editors check out performance and cost of 2400-, 9600- and 14,400-bps modems to help you select the most cost-effective alternative. You'll be surprised at what we discovered!

Over the last year or so, 9600 bits per second (bps) has gradually become the standard speed for modem transmission of data. And as is typical in the volatile computer industry, once something becomes a *de facto* standard, it comes time for a new, more technically advanced product to try to take over that coveted status. In this report, we'll look at three 9600-bps modems, and at two newcomers to the market that transmit at 14,400 bps.

One might expect that a 14,400-bps modem would perform about 50 percent faster than a 9600-bps model. Real-life performance, however, was disappointing by comparison: The fastest 14,400-bps modem was only 4.2 percent faster than the fastest 9600-bps modem we tested. Compared to the worst-performing 9600-bps modem, however, the 14,400-bps modems were 37 percent faster.

The bottom line? With a good 9600-bps modem like the U.S. Robotics Sportster 9600, you don't really need to spend the extra money for 14,400-bps communications. Unless every ounce of speed counts to you, save the extra \$100 or so. (Paradoxically, the 14,400-bps Practical Peripherals PM14400FXSA costs \$549—the same price as the 9600-bps Intel 9600EX. So double-check prices once you make your decision.)

But even 9600-bps modems are relatively expensive, at around \$300 to \$600. After all, you can join the Prodigy information service and get a 2400-bps modem—still a widely used transmission speed—for only \$49. Isn't that good enough?

Well, maybe. If all you're going to do is use Prodigy or GENie during off-prime hours, the answer is a resounding yes. Though the rate of data transfer can be excruciatingly slow

(if you're used to using a faster modem, anyway) these services charge a flat monthly fee irrespective of the amount of time you spend connected to them. Thus you pay no penalty for a slow modem.

But if you're going to use one of the information services that charge by the minute, or if you're going to be transferring very large files such as the 596,608-byte one that we used in our tests, then a faster modem is a must. For example, it took 42 minutes to transmit our test file at 2400 bps using the YMODEM-G protocol (a mean rate of 237 characters per second, or cps), and 50 minutes with the YMODEM protocol (200 cps). Using the Forval and Practical Peripherals 14,400 bps modems, that same file took only 4 minutes and 42 seconds to be transmitted (3,573 cps). Is your time worth the difference in price? If so, get a faster modem.

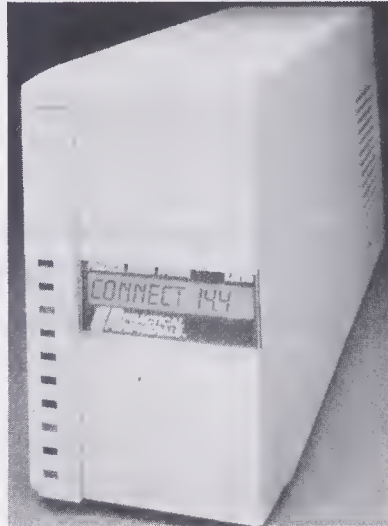
REVIEWS

Practical Peripherals PM14400FXSA V.32bis

The PM14400FXSA V.32bis modem from Practical Peripherals tied for first place with the Forval SA14400 modem, registering a data transfer rate in our test of 3,573 cps. This rate was only marginally higher than any we've received with the 9600-bps modems we've tested—even though our modem software, *CROSSTALK Communicator*, confirmed that we had established a connection capable of transmitting data at 57,600 bps.

The design of the modem is unusual: It's about the size and shape of a brick standing on edge. (To be precise, it measures 3 [W] by 5 [H] by 10.25 [D] inches.) It has the usual array of lights—10 in all—to provide the user with constant visual information about the modem and the status of its telephone connection. It has the seven standard lights plus one indicating an error-correcting connection (EC), one showing the status of the Request to Send (RTS) signal, and one showing the status of the Clear to Send signal (CTS).

All these status lights are quite nice, and can be really helpful if you know what you're doing. But most of us don't fall into that category—so Practical Peripherals has added a 12-



character LCD on the front panel to tell you in plain English the speed of the connection, the protocols in use, the quality of the connection, and other vital statistics. It's the first display we've seen that actually gives you helpful, easy-to-use information—a fabulous innovation.

When making a connection, the PM14400FXSA will automatically negotiate for the best possible connection. To help it perform this task the modem is capable of automatic fallback to lower line speeds as well

as automatic speed buffering of data that is sent.

Another innovative feature is the ROM-based HELP screens that can easily be accessed from your communications program. As if all this weren't enough, the device can also send and receive Group 3 faxes under Class 1 operation at 9600 bps.

The documentation that comes with the modem is extensive, complete, and very well indexed. One manual deals with the modem itself, while a second deals with software that comes with the unit. No, you're not mistaken: a communications software package is included as well. It's called *QuickLink II*, and it handles the sending and receiving of both files and faxes.

For those of you who are making an effort to support products made in the U.S.A., here's one you can buy in good conscience. It's even covered by a lifetime warranty. In short, the PM14400FXSA is simply one of the best modems we've ever seen.

Price: \$549. **Company:** Practical Peripherals, 375 Conejo Ridge, Thousand Oaks, CA 91361, (805) 497-4774.

Forval SA14400

This was the only other 14,400 bps modem that we tested. Like the PM14400FXSA v.32bis model from Practical Peripherals, this modem turned in a data transmission speed of 3,573 cps. The modem features the

full complement of hardware protocols to allow it to send and receive data at speeds up to 57,600 bps, and, like the Practical Peripherals unit, it contains an LCD readout panel. The Forval display, however, doesn't de-

cipher the alphabet soup of codes often associated with modem status indicators—it just shows the two-letter codes themselves. It's also used to let one completely program transmission parameters from the front

panel. For that, we applaud Forval—but we wish the company had gone further and eliminated those codes.

To our knowledge, Forval is the only modem manufacturer that keeps the software built into your modem up to date forever. A telephone line called FORVALink allows you to download software upgrades and improvements directly into your modem from Forval's headquarters.

The company makes two kinds of downloads available: improved code and upgrade code. The improved code is a debugged version of the software you receive when you buy a Forval modem, and is available for free to any user. (In the fast-moving computer market, new software can sometimes be released before it's been fully debugged, and Forval is to be commended for trying to keep its customers happy.) Upgrade code, by comparison, adds new capabilities to your modem—increased speed, for example—and is available for a fee. We think both options are great ideas

and would like to see other manufacturers jump on the do-it-yourself upgrade bandwagon.

Operation of this modem is fairly straightforward and takes no more than 5 or 10 minutes to get up and running. As the modem is aimed at first-time users, Forval also includes a free copy of *CROSSTALK Communicator*. This handy program supports many but not all popular software protocols. It doesn't handle Kermit or ZMODEM—but these and others can be added with third-party add-on modules. We love *Communicator*: we use it ourselves for our everyday communication.

The modem comes with two manuals, one about the modem itself and one for *Communicator*. Both are well-prepared and helpful.

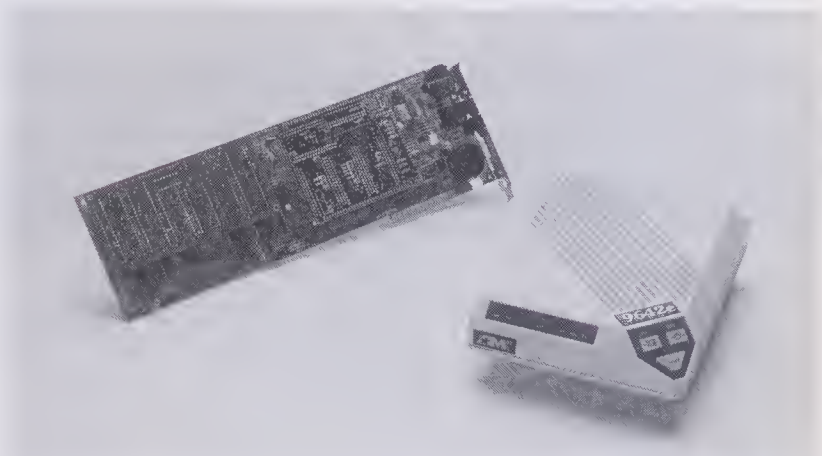
In all of our work with the Forval SA14400 modem we only found one flaw: It has no POWER switch. You have to unplug it when you want to turn it off, or plug it into a switching center. How about it, Forval?



Price: \$995. **Company:** Forval America, Inc. 6985 Union Park Ctr., Ste. 425, Midvale, UT 84947, (800) FORVAL1, (801) 561-8080.

AMT Star 9642e

The AMT Star 9642e is a 9600-bps modem containing all the appropriate protocols—V.32, V.42, V.42bis and MNP 5—to insure error-free throughput at 38,400 bps. Unfortunately, while it turns in an outstanding performance with the YMODEM software protocol (1,719 cps, the highest of all 9600-bps modems tested), it does only fair under the YMODEM-G protocol, with a data transmission speed of only 2,616 cps. This modem's performance is an important reminder to make sure you know which software protocol you're going to use most before you buy a modem. Don't make the mistake of



AMT Star® 9642i Internal Modem
AMT Star® 9642e External Modem



assuming that if a modem does well with one protocol it will do comparably well with another.

The front panel of the modem sports 11 indicator lights and three pushbuttons: a RESET switch, a dual-mode Originate/Answer switch, and a dual-mode Talk/Data switch. Each of the two dual-mode switches uses one of the 11 indicator lights to display its current state.

The manual that accompanies the modem is short, with no illustrations and no index. Though it was fairly

adequate, it didn't tell us the purpose of the two DIP switches on the rear panel of the modem. (We finally found out that they switch the modem into a Dumb mode, shutting off the Hayes AT command language so the modem can be connected to mainframes or other, incompatible systems.)

The modem also comes with a disk that contains a version of the *Quick Link II* communications program. No manual is included, but a file on the disk contains documentation that you

can print out yourself.

We found the Star 9642e to be as easy to use as the others and encountered no particular problems other than its lackluster performance under YMODEM-G. If you're going to stick with the YMODEM protocol, this modem is the fastest of the lot.

Price: \$429. **Company:** AMT International Industries, Inc. 16571 Gemini La., Huntington Beach, CA 92647, (714) 375-0306.

Modem Speed

Table 1.

9600 and 14,000-bps modems compared using differing protocols: speed in Characters Per Second

Modem	Modem Speed (CPS*)	
	YMODEM-G	YMODEM
PracticalPeripherals		
PM14400FXSA V.32bis	3573	2116
Forval SA14400	3573	2116
AMT Star 9642e	2616	1719
2400 BPS Modem	237	200

* Number of characters in test file divided by number of seconds to transmit file over telephone line from Manhattan to Brooklyn.

Modems Compared: Dollar Cost to Transmit Test File

Table 2.

Transmission costs to send 596,608 byte file over GENie and CompuServe information networks based on modem transmission protocol speeds listed in Table 1.

Modem	GENie 2400		GENie 9600		CompuServe	
	Off Prime (\$.00/m)	Prime (\$.30/m)	Off Prime (\$.30/m)	Prime (\$.50/m)	2400bps (\$.213/m)	9600bps (\$.38/m)
Practical Peripherals						
PM14400FXSA V. 32bis	0	\$.90	\$.90	\$ 1.50	\$.64	\$ 1.14
Forval SA14400	0	\$.90	\$.90	\$ 1.50	\$.64	\$ 1.14
AMT Star 9642e	0	\$ 1.20	\$ 1.20	\$ 2.00	\$.85	\$ 1.52
2400 BPS Modem	0	\$ 12.60	\$ 12.60	\$ 21.00	\$ 8.95	\$ 15.96

COMPARISON CHART: 14,400-BPS MODEMS

Make/Model	Speed (bps)	Auto Fail Back	* Mounting	Bus Interface	Standards	Hayes AT compat.	Power Supply	Software Included	Error Correction	Speaker; Vol. Ctrl.	Other Features	Price
Cardinal Technologies MB 14450 V.32 bis	14,400/12,200/ 9,600/4,800/ 2,400/1,200/300	Y	I	8-bit	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis/ V.22	Y	AC	SECUREcomm	MNP 1-4, V.42 LAPM	Y; Y	lifetime warranty	\$449
14400 V.32bis	14,400/12,200/ 9,600/4,800/ 2,400/1,200/300	Y	E	8-bit	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis/ V.22	Y	AC	SECUREcomm	MNP 1-4, V.42 LAPM	Y; Y	lifetime warranty	499
Computer Peripherals ViVa 14.4/FAX	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/600/300	Y	E	8-bit	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis	Y	AC	Quick Link II FAX	V.42, LAPM, MNP2-4	Y; Y	fax from within any DOS application	\$899
FastComm FDX 9642T	14,400/12,000/ 9,600/7,200/ 4,800/2,400	Y	E	8-bit	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis	Y	AC	none	MNP 4, V.42, TCM	N; N	two level security, centralized configurations	\$1,199
Forval SA 14400	14,400/12,000/ 9,600/4,800/ 2,400/1,200/ 600/300	Y	E	—	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis	Y	AC	ForvalLink	V.42, LAPM, MNP 2-4	—	ForvalLink allows users to download system upgrades via telephone lines	\$995
GVC FM9696/144HV	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	I	8-bit	Bell 212A/103, CCITT V.32bis/ V.22bis/V.22	Y	AC	Quick Link II Fax/Data	V.42, MNP 2-4, LAPM	Y; Y	V.42 bis data compression	\$379
FM9696/144V	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	E	8-bit	Bell 212A/103, CCITT V.32bis/ V.22bis/V.22	Y	AC	Quick Link II Fax/Data	V.42, MNP 2-4, LAPM	Y; Y	V.42 bis data compression	399
SM144V	14,400/12,000/ 9,600/4,800/ 2,400/1,200/300	Y	E	8-bit	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis	Y	AC	—	MNP 2-4, V.42	—	security call back	659

* I = Internal E = External P = Portable All prices are U.S. suggested list. — = Information not available at press time. N/A = Not applicable

Make/Model	Speed (bps)	Auto Fall Back	* Mounting	Bus Interface	Standards	Hayes AT compat.	Power Supply	Software Included	Error Correction	Speaker; Vol. Ctrl.	Other Features	Price
Hayes ULTRA Smartmodem 144	14,400/12,000/ 9,600/7,200/ 4,800	Y	E	8-bit	CCITT V.32bis/ V.32	Y	AC	Smartcom III	CCITT V.42	—		\$1,199
Intel 14.4EX	14,400/12,000/ 9,600/7,200/ 4,800	Y	E	8-bit	CCITT V.32bis	Y	AC	CrossTalk	V.42	—	full-duplex	\$699
Octocom OSI 8196	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/600	Y	E	8-bit	Bell 212A/202S/ 103, CCITT V.32bis/V.32/ V.22bis	—	AC	none	MNP 4, V.42	N; N	diagnostics, memory	\$795
OSI 8396	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/600	Y	E	8-bit	Bell 212A/202S/ 103, CCITT V.32bis/V.32/ V.22bis	—	AC	none	MNP 4, V.42	N; N	auto dial restore, leased line monitoring	1,195
Practical Peripherals PM14400FXSA V.32bis	14,000/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	E	—	Bell 212A/103, CCITT V.32bis/ V.32/V.22bis, V.22	Y	AC	Quick Link II Fax	MNP 4, V.42	—		\$549
Telebit T3000	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	E	8-bit	Bell 212A/103J, CCITT V.32bis/ V.32/V.22bis/ V.22	Y	AC	none	MNP 2-4	—	15 preset configurations, password security	\$949
U.S. Robotics Sportster 14,400	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	E	8-bit	Bell 212A/103, CCITT V.42bis/ V.42/V.32/ V.22bis	Y	AC	none	MNP 2-4, V.42	Y; Y	V.42 bis/ MNP 5 data compression	\$519
Sportster 14,400 Mac & Fax	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	E	8-bit	Bell 212A/103, CCITT V.42bis/ V.42/V.32/ V.22bis	Y	AC	FAXSTF	MNP 2-4, V.42	Y; Y	V.42 bis/ MNP 5 data compression	599
Courier V.32 bis PC-bus int.	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	I	8-bit	Bell 212A/103, CCITT V.42bis/ V.42/V.32/ V.22bis	Y	AC	none	MNP 2-4, V.42	Y; Y	synchronous transmission, V.42 bis/ MNP 5 data compression	845

Make/Model	Speed (bps)	Auto Fall Back	* Mounting	Bus Interface	Standards	Hayes AT compat.	Power Supply	Software Included	Error Correction	Speaker; Vol. Ctrl.	Other Features	Price
Courier V.32 bis External	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200/300	Y	E	8-bit	Bell 212A/103, CCITT V.42bis/ V.42N.32/ V.22bis	Y	AC	none	MNP 2-4, V.42	Y; Y	synchronous transmission	895
UDS Motorola V.3229	14,400/12,000/ 9,600/7,200/ 4,800/2,400/ 1,200	Y	E	8-bit	Bell 103, CCITT V.32 bis/V.32/ V.22bis	Y	AC	none	V.42 LAPM, MNP 2-4	Y; Y	V.42 bis data compression, MNP 5, call security, remote configurations	\$995 (LED)/ 1,145 (LCD)
Western Datacom 432 Line Backer	14,400/9,600/ 4,800/2,400/ 1,200/300	Y	E	8-bit	Bell 212A, CCITT V.32bis/ V.22bis/V.22	Y	AC	none	MNP 2-5	Y; Y	level 8 diagnostics, auto dial back- up of leased lines	\$795
432-i Line Backer	14,400/9,600/ 4,800/2,400/ 1,200/300	Y	I	8-bit	Bell 212A, CCITT V.32bis/ V.22bis/V.22	Y	AC	none	MNP 2-5	Y; Y	level 8 diagnostics, autodial back-up of leased lines	795

MODEM MANUFACTURERS

Cardinal Technologies, Inc.
1827 Freedom Rd., Lancaster, PA
17601, (800) 233-0187, (717) 293-
3000

Computer Peripherals, Inc.
667 Rancho Conejo, Newbury Park,
CA 91320, (805) 499-5751, (800)
854-7600

FastComm Communications
45472 Holiday Dr., Sterling, VA
22170, (703) 318-7750, (800) 521-
2496

Forval America, Inc.
6985 Union Park Ctr., Ste. 425, Mid-
vale, UT 84947, (800) FORVAL 1,
(801) 561-8080

GVC Technologies, Inc.
376 Lafayette Rd., Sparta, NJ 07871,
(201) 579-3630, (800) 280-4821

**Hayes Microcomputer Products,
Inc.**
PO Box 105203, Atlanta, GA 30348,
(404) 840-9200

Intel Corp.
2200 Mission College Blvd., P.O. Box
58119, Santa Clara, CA 95052, (800)
538-3373, (408) 765-8080

Octocom Systems, Inc.
One Executive Dr., Chelmsford, MA
01824, (508) 441-2181

Practical Peripherals
375 Conejo Ridge, Thousand Oaks,
CA 91361, (805) 497-4774

Telebit Corp.
1315 Chesapeake Terrace,
Sunnyvale, CA 94089, (408) 734-
4333

U.S. Robotics
8100 McCormick Blvd., Skokie, IL
60076, (708) 982-5010

UDS Motorola
5000 Bradford Dr., Huntsville, AL
35805, (205) 430-8000

Western DataCom
925 Bassett Rd., Westlake, OH
44145, (800) 262-3311, (216) 835-
1510

On-Line Power Protection



If you regularly use a computer, you know the sickening feeling you get when a power failure reduces your last hour's work to the ominous silence of an unresponsive screen. In less time than it takes for the lights to flicker, your train of thought is disrupted and your productivity paralyzed. Do you even remember how to use a pencil?

Power blackouts aren't the only electrical nicks and bruises to afflict your computer and its many sensitive electronic parts. During the course of a typical work day, there may also be power disturbances in the form of variations in the supply of electrical current. These cause voltage fluctuations that could result in equipment malfunction, premature circuit failure, and information loss.

Conventional wall sockets usually supply 120 volts (V) of alternating current (AC). Your computer is equipped with a power supply that converts this AC power into direct current (DC). "Brownouts," voltage

dips, and electrical sags occur when the power supplied to a wall outlet falls between 90 and 105V AC. These glitches may be caused by the start-up power demands of electrical devices like refrigerators and air conditioners. They also can happen when your local power company reduces voltage levels to protect generating equipment from over-use in peak power periods (i.e., during excessive heat or cold spells).

Power surges (called "spikes" when they last less than 1/120 of a second) occur when there's a sudden dramatic increase in voltage flowing through the line. These may result from a lightning strike during a local electrical storm. More commonly, they are caused by transient variations in electrical loads produced by downed power lines, static electricity, or household appliances like refrigerators, clothes dryers, well water pumps, and air conditioners switching on or off.

Surge protectors safeguard your

computer equipment against potentially dangerous electrical spikes and surges. They intercept, then "clamp" down on a momentary voltage rise to prevent excess juice from passing through the lines to your system. The less voltage able to get through once a surge is detected, the better off your hardware will be. One standard, set by Underwriters Laboratories, Inc. (UL) in 1988, rates 400 volts peak or less as the maximum safe pass-through permitted after clamping. Even inexpensive surge protectors are usually rated at 350 volts or less.

Clamping time is only one factor you should consider when purchasing a surge protector. Another is response time. Generally the faster a surge protector's response time (measured in nanoseconds or billionths of a second), the sooner the device kicks in and clamps down on an incoming surge. Response time ratings of 5ns or less are considered good. Those of less than one picosecond (trillionth of a second) are better.

Another important factor to consider before you buy a surge protector is the model's "energy rating," measured in joules (a unit of energy). The higher the energy rating, the more voltage the device can absorb before it crashes and dissipates the surge into the ground. More expensive surge suppressors have energy ratings of 300 joules or greater.

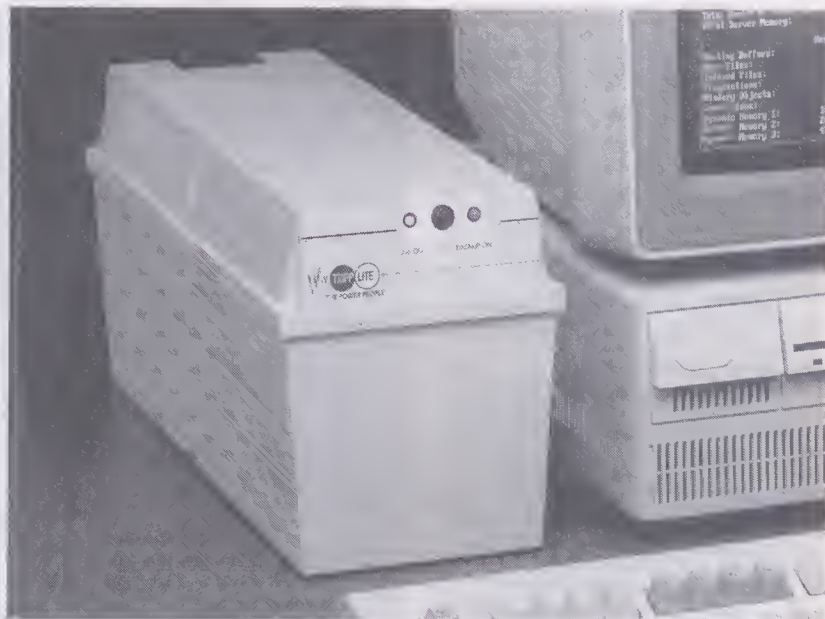
Line impurities like Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) also affect an AC power cycle. Just as the motor in an electric shaver or food processor can cause your television screen to exhibit white lines (“fuzz”), motors in office equipment like photocopiers and air conditioners or radio transmitters generate a similar “noise.” This interference can cause hardware malfunctions resulting in data loss.

RFI/EMI filtered surge protectors improve the quality of power transmitted, by reducing the amount of radio and frequency pollutants that pass through the lines.

Who Should You Call?

Surge protectors and noise filters smooth fluctuations in electrical current, but can't boost power in the event of a brownout or blackout. How do you safeguard equipment and minimize data loss during a power outage?

Most experienced computer users can avoid serious problems by turning off and unplugging machines and peripherals (modems included) before the onset of a major storm. You can also train yourself to save work files in progress at regular intervals. (Some programs like Microsoft *Word* feature automatic save settings.) However, it's impossible to forecast power disruptions that occur within a building when load demands are excessively heavy, nor can you predict



The Tripp Lite BC 900LAN offers monitoring software for LANtastic, AppleShare, and other popular Networking systems, and a LAN interface port for automatic, unattended network shutdown.

the exact moment when a local utility substation will experience an electrical malfunction.

Power companies sometimes shut off current to correct a line problem or to switch electrical loads from one generator to another. Even these temporary electrical outages may be hazardous to your computer's health. As this country's aggregate electrical load increases, you can expect black-outs to occur more often.

We Stand on Guard for Thee

To protect computers and sensitive data against too much or too little power, and to filter electricity received from the utility company, computing enthusiasts are increasingly turning to uninterruptible power supplies (UPS). These devices furnish emergency power during blackouts and improve power quality during brownouts, surges, and spikes. They are designed to provide consistent high-grade voltage to connected

equipment. When an electrical problem occurs, they can begin supplying or boosting power in less than a millisecond (1/1000th of a second), so your computer never experiences any down time.

According to industry surveys, unit shipments of UPS devices grew by nearly 20 percent from 1990 to 1991. Continued market growth is expected as prices drop, technology improves, and the quality of electrical power declines. Analysts are predicting revenues of more than one billion dollars for this market segment by the end of 1992.

Just a few years ago, UPS devices were oversized and noisy. As a result of technological innovation and the trend toward miniaturization, today's models have a sleeker, smaller look. Several not only filter out line sags and spikes, or kick in during black-outs (thereby eliminating down time), they also come with monitoring software able to diagnose line conditions and warn users of potential problems.

There are basically two kinds of

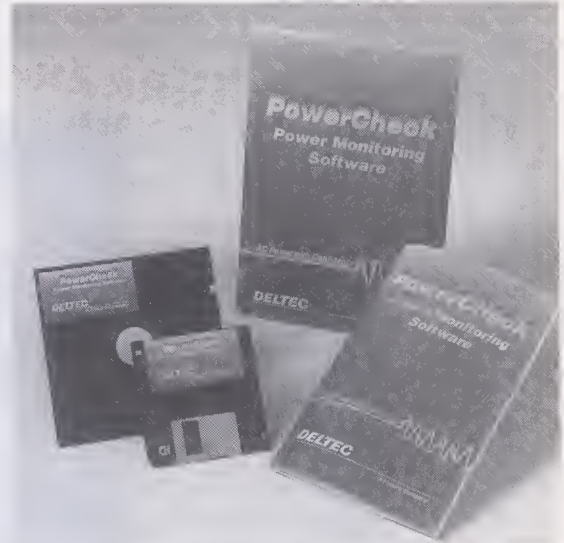
UPS devices: Standby and Online. Internal components for both types are quite similar. Each one contains a battery charger, batteries, surge suppressor, noise filters, plus a DC to AC inverter which translates battery (DC) voltage into AC current. Computer equipment plugs into outlets at the rear of a UPS panel. Some UPS devices have more outlets for direct connection than others. Life expectancy for UPS batteries ranges from 2 to 6 years. Optional battery packs suitable for daisy-chaining are available for some models.

UPS devices draw power from conventional AC wall outlets to keep battery chargers charging. The batteries in "Standby" units, however, only power connect equipment when utility supplied power drops below a certain minimum voltage (usually 105 volts). Standby units cost less than "Online" devices, because they exhibit a minuscule transfer time during a power failure as they switch from AC filtered input to the battery operated inverter power source. With Online UPS devices, the battery is the primary source of power, so there's no transfer time lapse during an input AC power failure (since input AC

isn't the primary source of power). Since Standby transfer times are really so minuscule, these units are just as dependable as Online models.

Line-interactive UPS devices (sometimes called Intelligent systems), have become popular recently, especially in network environments. These UPS models are hybrids. They combine the best features of both Standby and Online uninterruptible power supplies, including continuous output with no break performance, battery charging by operating the inverter in reverse when input AC power is normal, and standby model pricing. Frequently, they include power monitoring intelligence capabilities through software that tracks power quality, analyzes power line anomalies, and outputs findings to a spreadsheet.

The length of time any UPS device can power a system depends upon its



Deltec also supplies a utility to monitor their UPS systems and PC's and LAN servers.

volt-amps (VA) rating and the size of its direct connect output load. In other words, an 800 VA unit might provide uninterrupted power for 6 minutes at 600 Watts, but it can handle 450 Watts for 12 minutes, 300 Watts for 20 minutes, or 150 Watts for 50 minutes. Powerful computers with 256-color, full-page, or 2-page monitors and large-capacity hard drives require UPS devices with higher VA ratings than floppy-based XT or AT systems with 14-inch monochrome monitors.

For example, a 10-MHz AT or 16-MHz 386SX clone with 5.25-inch floppy drive, hard disk drive, VGA card and 14-inch color monitor draws enough power for a UPS system rated at 250 VA, while a desktop 386 or i486 system requires a UPS unit rated at 400 VA. Tower 386 and i486 systems may be safer with a 450 VA model. VA requirements for local area networks (LANs) with multiple servers and workstations, inter-networking hardware such as bridges, gateways, routers and hubs, and telecommunications equipment could go as high as 1250 VA.

The best way to choose a UPS device is to total the Amp ratings of all equipment you plan to direct connect. Ratings are usually listed on a

Companies That Market UPS Devices

American Power Conversion
P.O. Box 278
132 Fairgrounds Road
West Kingston, RI 02892
(800)541-8896 or (401)789-5735

Best Power Technology, Inc.
P.O. Box 280
Necedah, WI 54546
(800)356-5794 or (608)565-7200

Cuesta Systems Corporation
3440 Roberto Court
San Luis Obispo, CA 93401
(800)332-3440 or (805)541-4160

DELTEC
2727 Kurtz St.
San Diego, CA 92110
(800)854-2658

Para Systems, Inc.
P.O. Box 815188
Dallas, TX 75381-5188
(800)238-7272 or (214)446-7363

SHAPElectronics, Inc.
901 N. DuPage Ave.
Lombard, IL 60148
(800)367-5811 or (708)620-0784

Tripp Lite
500 N. Orleans
Chicago, IL 60610-4188
(312)329-1777



UPS systems used to be behemoths that took up more space than the PC they protected. Today they are sleek, small and weigh a fraction of what they used to. This model from PowerRite fits under the monitor.

device's rear panel or in the Owner's manual. Multiply the Amp total by 120 to estimate the VA requirement (i.e., Amps x 120 Volts = VA). Since equipment Amp ratings usually err on the side of caution, you can be sure a UPS device designed to handle your estimated VA requirements will be more than sufficient.

You might want to buy a model with a slightly higher power specification if you think you may be expanding your system in the future. In any case, be sure to purchase a model capable of providing computer-grade power at maximum load requirements for at least 15 minutes in the event of a blackout. This should be more than ample to work without interruption, close files, and safely power down your system, when everything else around you is in the dark.

Taking Charge

Today, UPS devices come in all

shapes and sizes. Some small footprint models sit on a desktop next to the computer, delivering power unobtrusively. Other units rest on the floor. Many are designed for standalone computers. Several are powerful enough to handle heavy-disk-drive usage on loaded network file servers. More and more units are equipped with a network interface, so they can be used with automatic shutdown and power monitoring software.

Better models have a series of front panel indicator lights that kick in whenever your equipment switches to battery power, remaining battery capacity is low, power demands outstrip UPS power supply, or site wiring is faulty. They provide user adjustable option switches which tailor voltage transfer levels to a particular site, and sound an alarm at regular intervals while the power is out to keep you advised of the failure. They incorporate battery self-tests; line

diagnostics which test building wiring for persistent high or low line power conditions, poor ground or reversed AC polarity; and network monitoring. They also provide a sine wave or stepped approximation to a sine wave output rather than a square wave output for more regulated voltage and less wear and tear on direct-connect peripherals.

UPS systems start as low as \$150, but for 5 minutes at 400 VA (386/33 with a 19-inch VGA monitor) or 15 minutes at 200 VA (386SX with 14-inch VGA monitor), list prices begin at about \$300. The more bells and whistles you require (e.g., network monitoring in the form of power-management software with automatic file saving) or the higher the VA rating, the greater the expense. Given the alternatives, cost-sensitive buyers should quickly realize that money is a small price to pay for computer-grade power that minimizes hardware malfunction and data corruption. A UPS with built in surge protection, line conditioning, and noise filters is your best protection against inconsistent current (voltage fluctuations). If you want peace of mind and guaranteed productivity during a power disturbance, a UPS is the only way to charge ahead! ■

Publication of Note

Title: PC Power Protection (1989), 220 pp.

General (but technical) introduction to computer electrical power. Chapters on basic electricity, recognizing power problems, voltage transients, PC power supplies, surge suppressors, power-line conditioners, standby power systems, and more.

Author: Mark Waller

Publisher: SAMS, 11711 N. College Ave., Carmel, IN 46032; (800)428-5331 or (317)571-3489

Price: \$19.95

For R-e-a-l-l-y BIG Storage, Upgrade to An Optical Disk Drive

Are you being buried alive by files? If so, let our experts explain the technology and tell you how to install an optical disk drive.

Despite the recent dip in cost per square foot for office space, the long-term trend is upward, so office space is getting more expensive; why fill it with filing cabinets instead of productive workers? Besides, who wants to step over piles of paper everywhere? If you add up rent per square foot, clerical wages, and supplies, a five-drawer filing cabinet with 10,000 sheets of paper in it can cost over \$2,000 a year to maintain—a storage cost of more than 20 cents per page, or \$4.50 per megabyte of information. A 3.5-inch optical disk will store 128Mb for about 40 cents per megabyte; a 5.25-inch optical disk will hold 650Mb for about 30 cents per megabyte. Before your storage needs outgrow your hard disk, consider installing an optical disk drive. It can store 128Mb, or 650Mb, or even 1,000Mb—one gigabyte—on a removable disk. There are also “jukeboxes” that hold

multiple optical disks, giving users access to dozens of gigabytes of data. Optical disk drives have been on the market for more than ten years. Like most computer hardware, prices continue to fall. It takes almost the same skills to install an optical disk drive as a hard disk drive or a tape backup drive, so let's see what's involved.

Read-Only and Write-Once

There are several disk drive technologies that are “optical,” but we'll focus on just one of them. (It helps to get them all in perspective.) The Compact Disc (CD) is the most widely used optical storage medium in use today, but like a vinyl record, it's not a recording medium. The shiny recording layer below the clear plastic surface has been stamped in a factory with tiny pits representing digital data. Inside a CD player, a laser beam

reads those pits as ones and zeros. The circuitry translates that data into music. Any digital data can be pressed into CDs and played. Although a CD can hold more than 700Mb of data, users can't record on it. It's a one-way medium, known as a Compact Disc/Read-Only Memory, or CD-ROM. But most users don't just want to read someone else's data; they want to record their own information. The first optical disk systems used technology similar to that of the CD, in which a laser either burned pits into a disk or caused a chemical reaction that created permanent marks. Using special software, you can direct the computer to disregard some data sectors in favor of others, such as those sectors that have been more recently recorded. So for all practical purposes, data on such a disk can be updated even though what's recorded can never be erased. Drives employing this technology are



The Ricoh Transporter 3000 3 1/2" rewritable optical drive fits both tower and chassis configurations. This drive's average seek time is less than 45 milliseconds, and its data transfer rate is 640Kb/second. Each disk holds up to 128Mb of stored data.

known as "write once/read many" or WORM drives. WORM technology is now used mainly in specialized applications, and in drives with very large (12-inch or 14-inch) disks.

Magneto-Optic (MO) Drives

Most users, however, are accustomed to erasing and re-using media, after so many years' experience with magnetic disks. Optical disks that are erasable and rewritable employ a combination of magnetic and laser circuitry that's more accurately called magneto-optic, or MO (pronounced em-oh). MO is the best-selling kind of optical disk drive, and is the easiest for users to install themselves. MO drives come in familiar 3.5-inch and 5.25-inch disk sizes. In every magnetic disk drive, an electromagnet in the drive head magnetizes microscopic particles of ferrous (iron-based) material. One polarity (north) is interpreted as a digital one, while the opposite polarity (south) counts

as a digital zero. The particles stay in their polarities until they are reoriented by another pass under the magnetic head. If those particles are packed too close together, they reorient one another, and thus disrupt the integrity of the data they represent. This limits the storage capacity of magnetic media. But the ferrous materials used in MO disks are different. They have to be heated to a high temperature, known as the Curie point, before their magnetic polarity can be changed. In an MO drive, a tiny, focused laser heats up small spots of those MO particles. A magnetic head orients the spot's polarity. As soon as that spot rotates past the laser beam, however, it cools down quickly. Its data can't be altered until the spot is reheated and remagnetized.

The MO Advantages

An MO disk has three big advantages over a conventional magnetic disk:

- Data can't be accidentally erased

or corrupted by a magnetic field. You could stick an MO disk on a refrigerator door with a magnet and not disturb the data. Laboratory tests suggest that, when stored properly, an MO disk should retain its data intact for at least a decade and probably longer.

- Storage capacity is ten times greater than that of the same size magnetic disk. An MO disk holds more than a hard disk can, yet—like a floppy—the disk is removable.
- There's no chance of a head crash with an optical drive. The read/write head never comes close to the disk surface. You can even turn an optical disk drive on and off while there's a disk inside and do no harm to either.

Admittedly, there are also some tradeoffs. Although the cost-per-megabyte is lower for optical storage than for magnetic storage, the extra capacity means that the purchase price of an optical disk drive is much higher. An MO drive is also slower when reading or writing data than most hard disk drives are—although it's faster than a floppy or a CD-ROM.

Drive Options

MO drives are available as standalone units in 3.5-inch and 5.25-inch sizes. A 3.5-inch disk is single-sided and can be formatted to hold a maximum 128Mb. Because 3.5-inch drives are smaller than 5.25-inch drives, they are also available as internal drive units. The leading manufacturers are IBM and Mass Optical Storage Technologies (M.O.S.T.). A 3.5-inch disk drive will retail for about \$1,500-\$1,800. Each disk will retail for about \$50-\$65. Among 5.25-inch drives, Sony is the best-seller; but there are many competitors. A 5.25-inch disk is double-sided; when formatted for 650Mb capacity, there will be a maximum 325Mb of user data per side. (You have to flip the disk over manu-

ally.) Almost all 5.25-inch disks are formatted to this industry standard of 650Mb, but unlike floppy disks, the interchangeability of disks among competing vendors' drives is not yet standardized. However, if all your drives come from the same manufacturer, and if you format the disks with a single vendor's driver software, the disks can be used in all the drives interchangeably. A 5.25-inch drive will retail for about \$4,000-\$5,000. Each disk will retail for about \$80-\$100. One manufacturer's drive goes beyond 650Mb capacity: the Maxtor Tahiti (made by Maxoptix). It also uses 5.25-inch MO disks, but offers a format option for 1Gb of storage (500Mb per side). Tahiti disks formatted for 1Gb are not compatible with 650Mb disks.

SCSI Devices

Almost all optical disk drives are controlled by hardware and software conforming to the Small Computer Systems Interface, or SCSI (pronounced "scuzzy") standard. If you have a hard disk drive in your PC that you know is a SCSI device, there will be a SCSI controller card plugged into your computer's motherboard, and a SCSI port in the back of the computer. In this case, you can skip many of the installation steps outlined below for PC-compatible systems. (Apple Macintoshes come with a SCSI port standard.) Each SCSI device gets a unique address along the cable—like individual telephone numbers on a single line. A SCSI controller card can handle up to seven SCSI-compatible devices, so once you've installed the card, you can add more optical disk drives, magnetic hard drives, or tape drives. You'll need to purchase a SCSI kit, which includes the SCSI controller card and software drivers. Kits made by Corel are shipped with most optical disk

drives, but there are other reliable interface kit makers as well. It's wise to buy whatever brand of board and driver the disk drive manufacturer recommends; all of them will come with explicit instructions. Like optical disk drives, SCSI kits are available at retail from large, well-stocked computer stores, and by mail order. While they aren't yet commonplace in all retail stores, most large mail order houses carry them. There are also advertisements from vendors and manufacturers in national and regional computer magazines.

Installing An Optical Drive

The procedure for installing an optical disk drive is as straightforward as that for any other external drive, according to Bill Odell, a senior partner in Shaw, Novinger & Odell, of Berkeley, CA, which specializes in optical disk-based document image systems. "You need an empty slot on the motherboard of your PC/XT, AT, or 386," he says. "But most SCSI cards are half-size cards, so unless you have a very old PC, you should have enough room on the motherboard to put the half-size card in a slot. If there's already a SCSI card, you prob-

ably don't need another. You won't need a larger power supply, because the optical drive is external and will have its own AC power cord."

Here are step-by-step instructions for installing an optical disk drive:

Step 1. There are some switches to set on a new SCSI board before it's installed, but Odell insists that users follow the specific manufacturer's instructions for them.

Step 2. Open the computer case and locate an empty slot. Unscrew and remove the blank at the back of the computer (it's not needed) but keep the screws. Use them to secure the external, port end of the SCSI card after plugging the card into its slot.

Step 3. The interface kit will include a standard SCSI cable. Plug one end into the port at the computer, and the other end into one of the SCSI ports on the standalone optical drive. The other port is available as a pass-through for another SCSI cable when daisy-chaining additional drives. The last drive in a SCSI chain, however, must have a terminating plug in the unused connector. This plug will come with the drive; install it if it's not already in place.

Step 4. Set the drive's SCSI address. "This is the only manual op-

Storage Capacities of Various Media

	3.5-Inch Floppy	Disk Type 3.5-Inch Optical	5.25-Inch Optical
Capacity	1.44Mb	128Mb	640Mb
ASCII Text Pages	6,000	58,000	300,000
Office Document Images			
A4 (8.5in. X 11in.) pages	250	3,200	16,000
Engineering Drawings			
A0 [22in. X 34in.] pages	10	340	1,700

eration required," says Odell, "and how it's set will depend on whether the drive is the only SCSI drive in use, or is one of several.

"There will be two switches on the back of the drive, as there are on every SCSI device. These set the identification (ID) number and the logical unit number (LUN). Most drives are shipped pre-set as ID 0 (zero) and LUN 0 (zero). If this drive is the only SCSI device in the system, you can leave those settings as they are.

If there are more SCSI devices—or when adding more in the future—each device will need a unique ID and LUN number. The instructions that come with the drive will describe how to do this."

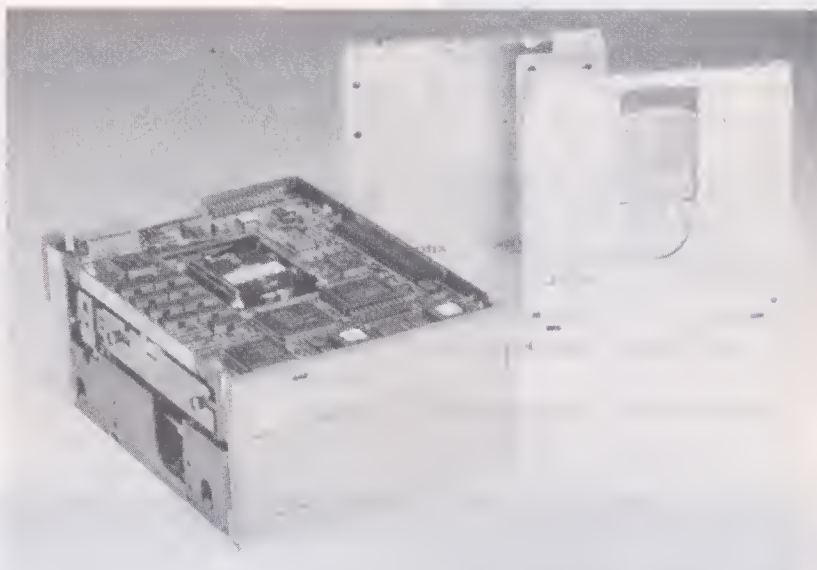
Step 5. Plug in the drive's AC power cord and turn on the power switch. Insert a disk cartridge. You will probably be able to hear the drive spin up to speed. The ready light should come on.

Driver Software

You'll have to install new driver software. "At this point, DOS or Windows or whatever shell you're using will have no knowledge of this optical drive," says Odell. "Because optical drives have such large capacities, and the disks are removable, special device drivers are required. These include special formatting, diagnostic, and disk utility programs. Your regular DOS CHKDSK, for example, doesn't work with an optical drive."

Here are the steps you need to take to install new driver software:

Step 1. Before starting the software installation, turn on your computer and go to the root directory of the boot disk (i.e., the internal hard drive, usually drive C:). Copy the files called CONFIG.SYS and AUTOEXEC.BAT onto a floppy dis-



The disks for the Tahiti II Drive from Maxoptix have a storage capacity of up to 1-Gbyte, and cartridges are rewritable from 10 to 100 million times. The drive's SCSI bus transfer rate is up to 4-Mb/second, and jukebox versions, drives holding multiple disks, are available.

kette, and put that floppy aside. This protects your original CONFIG.SYS and AUTOEXEC.BAT files in case anything goes wrong during the installation of the optical disk driver.

Step 2. The optical disk interface kit will come with a floppy diskette containing the driver software. Put that diskette into drive A, type A: [return] and type INSTALL at the A> prompt.

Step 3. The INSTALL program will lead you through each step. It will suggest that you create a directory in your hard drive (C:) for the optical disk drive software. It will ask you to enter the SCSI board address (the ID and LUN number), the type of drive (Sony, Pioneer, etc.), and specific or technical details about the drive that will be found in the drive's instruction manual (such as the size of the maximum logical sector, or the number of logical volumes to be recognized).

"Don't worry about these technicalities," says Odell. "Just enter the data. Manufacturers' documentation

is generally very good, and this information will be easy to find. When in doubt, accept the default setting."

Step 4. Once the INSTALL program has been run, it will ask for permission to install the device driver in the CONFIG.SYS file. Go ahead and let it install automatically. ("You backed up the original CONFIG.SYS before, didn't you?"). The INSTALL program will also automatically change the AUTOEXEC.BAT file to include a path for the optical disk drive software.

Step 5. Now re-boot, using CONTROL-ALT-DELETE. When the system comes back "up," the device driver should have been read, and the optical drive should be available in the next letter-named drive. That is, if two floppy disk drives are A: and B:, and the hard disk is C:, the optical drive will become drive D:. If you have previously partitioned your hard disk drive into logical drives (i.e., D:, E:, F:, etc.), the optical drive will be assigned to the next unused letter in alphabetical order.

Formatting Optical Disks

"Now you are ready to format your optical disks," says Odell. "The procedure is very similar to that for formatting floppy disks, but the computer will take quite a bit longer to format the first optical disk than it would for a floppy disk. Be patient. Subsequent optical disk formats in this session will be done more rapidly."

Here are the steps you need to take

to format optical disks:

Step 1. Refer to the interface kit documentation and find the name of the format program for your optical disk. (In the Corel interface kit, that program is called CFORMAT.)

Under DOS, type that program name and press [RETURN.] If you're running *Windows*, double-click on the program you want to run; with any other shell, follow the normal procedure required to select and run a program.

Step 2. 3.5-inch MO disks are single-sided, and will be formatted to hold 128Mb of user data per side. 5.25-inch MO disks are two-sided, each capable of holding 325Mb. When you have formatted one side of a 5.25-inch disk, remove it from the drive, invert it, and format the other side.

Now the optical drive is available for use, and will operate in exactly the same way as any other drive in the system. ■

Companies Featured

Consultant:

Shaw, Novinger & Odell
2140 Shattuck Ave.
Suite 1103
Berkeley, CA 94704
(510) 841-9426
Fax: (510) 841-9437

Driver Software/SCSI Kits

Corel Systems Corp.
Optical Products Division
1600 Carling Ave.
Ottawa, ON, Canada K1Z 8R7
(613) 728-8200
Fax: (613) 728-9790

3.5-Inch Drives

IBM [all info]
Contact local IBM branch office
(800) 426-3333
International inquiries phone (201)
329-7113

Mass Optical Storage Technologies (M.O.S.T.)
11205 Knott Ave.
Suite B
Cypress, CA 90630
(714) 898-9400
Fax: (714) 373-9960

5.25-Inch Drives

Hewlett-Packard Co.
Information System Group
19091 Pruneridge Ave.
Cupertino, CA 95014
(408) 447-1006

Hitachi America, Ltd.
Hitachi Plaza
2000 Sierra Point Pkwy.
Brisbane, CA 94005-1819
(415) 589-8300
Fax: (415) 583-4207

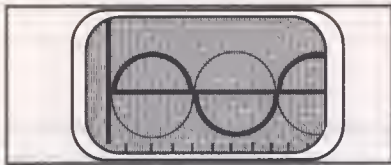
Maxoptix Corp.
2520 Junction Ave.
San Jose, CA 95134
(408) 954-9700
Fax: 408-954-9711

Panasonic Office Automation
Panasonic Communications and
Systems Company
Two Panasonic Way
Secaucus, NJ 07094
(800) 742-8086 or (201) 348-7183

Pioneer Communications of America
Optical Memory Products Div.
1058 East 230th St.
Carson, CA 90745
(213) 513-1016
Fax: (213) 513-1381

Ricoh/Olympus
Ricoh File Products Division.
5150 El Camino Real, C-20
Los Altos, CA 94022
(415) 962-0443
Fax: (415) 962-0441

Sony Corp. of America
Sony Drive
Park Ridge, NJ 07656
(201) 930-6432



Increasing Disk Storage Capacity

Are you running out of disk space and dreading adding a new drive? If so, maybe one of these data compression programs can help.

If you'd rather not experience all of the fear and anxiety associated with adding a new disk drive, but still want to enjoy the advantages of extra storage capacity, there's now an alternative, disk compression software and hardware. By using this fairly new class of computer add-ons, you can double or even triple (depending on the data that's being stored) the capacity of your current disk drive, all at very little additional cost. And, as an added bonus, you'll also be able to double the storage capacity of your floppy diskettes as well.

There are several disk compression products available. These include: *Stacker* from Stac Electronics, *SuperStor* from AddStor, *DoubleDisk* from VertiSoft Systems, and *Expanz!* Plus from Infochip Systems for PC-based systems, *AutoDoubler* from Salient Software, *More Disk Space* from Alysis Software, *Stuffit* from Alladin Systems, and the DoubleUp board from Sigma Designs for Macintosh systems.

In addition to these products, there's another class of compression programs that are used mainly to

archive files. These include *LHA*, a shareware program from Japan, and *PKZIP* from PKWARE, Inc.

All of the real-time disk compression products (*Stacker*, *SuperStor*, *Expanz!*, etc.) operate in a similar, although not identical manner. All use the same basic compression algorithm and produce comparable results. It's recommended that you back up the files on your hard disk drive before using any of these products. We haven't encountered any problems that would make it necessary to use the backup, but why tempt fate.

REVIEWS — PC Compression Packages

Stacker

This was one of the first disk compression products to appear. It comes as an add-in hardware card for XT, AT, and MicroChannel systems as well as a standalone software program. The cards are faster, so it's possible to get a higher degree of compression in the same amount of time than with the software-only option. The XT card costs \$199; the AT card costs \$249; and the Micro Channel card costs \$229. The software only version of the product costs \$149.

If you're going to use the hardware version of *Stacker*, you'll have to go through the inconvenience of opening up your computer case. This can

be a daunting experience for people with two left hands. If you're one of these people, either have someone install the card for you, use the software only version of the product, or use *SuperStor*. Installation is simple and straight-forward. The board comes ready to use from the manufacturer and no adjustments or switch settings need to be made. All you need to do is plug it in, turn the computer on, and run the installation program on the diskette provided.



If you use the hardware version of the program and something happens to the card, there's no need to panic. The system will automatically run the software version of the program if

it detects a problem with the card or even if the card has been removed from the computer. Like the hardware version, the software version just sits there and compresses data

without you even knowing it. The only difference is, it's slower. Because of this slower operating speed, the program can't spend as much time as it needs to compress the data,

so files compressed by the software only are about 10% larger than those compressed by the card. That's the only difference in the operation of the two versions.

SuperStor 2.0

SuperStor is very similar to the software version of *Stacker*. It does, however, have some additional capability that compensates for the slower speed of a software product versus a hardware product. At \$139, *SuperStor* costs \$10 less than the software version of *Stacker*.

To compensate for the fact that it's slower than the hardware version of *Stacker* and thus doesn't have enough time to compress data as much as it can, *SuperStor* comes with a handy recompression utility. With this program, it's possible to take a file that has already been compressed by *SuperStor* and make it even smaller. The program can shrink already compressed files by as much as an additional 25 percent, depending on the type of data involved. Typically, however, the extra compression ranges from 10 percent to 20 percent.

The recompression utility isn't part of the "behind-the-scenes" *SuperStor* program and unlike *SuperStor*, it must be manually activated whenever it is to be used. It's a good idea to run it at the end of the day, just before you turn your system off. As part of its normal operation, the recompression program automatically activates the defragmenting utility, so in addition to increasing your storage capacity,

you're also increasing your disk speed. By the way, the defragmenting program is also run when *SuperStor* is first installed, so you may notice an immediate improvement in speed after you start using *SuperStor*.

Defragmenting a disk (reorganizing the disk so that programs are stored in consecutive sectors on the disk and are thus faster to retrieve) is a time-consuming process and sometimes you may prefer to increase disk speed without having to go through it. *SuperStor* lets you do that too with its consolidate utility. This program performs a function that's similar to that performed by defragment by pulling far-flung pieces of the file together into a single location. Unlike the defragmenting utility, however, it doesn't place that information in the proper order. Thus, it keeps all the information for a particular file together, but not necessarily in the order that it's needed. Hence you get some improvement in speed without investing the time you'd ordinarily need to defragment the disk.

Another *SuperStor* bonus that's really nice is its ability to create transportable compressed floppy diskettes.

While both *Stacker* and *SuperStor* allow you to compress floppy disks,



SuperStor goes one step further and allows you to create a "universal" disk that can be used even by people who don't have *SuperStor* installed on their system. In this case, a small program called *2XON* is added to the diskette. When *2XON* is run on a system without *SuperStor*, it gives that system the ability to read, but not write, a compressed floppy. Thus, you can store 2.5Mb of data on a 1.44Mb diskette and give it to someone who doesn't have *SuperStor*. They can then read it from that diskette and save it on their own system in its full, uncompressed form.

Expanz! Plus

Like *Stacker*, *Expanz! Plus* is a compression product that's available in both a hardware and a software version. And, like *Stacker*, if anything happens to the board, the software version will take over and continue to

let you use the expanded drive.

The price for *Expanz! Plus* is low, only \$149 for both the board and the software; the same price that *Stacker* charges for their software version alone. The product isn't as much of a

bargain as it seems, however. While you would normally expect a compression board with a coprocessor on it to be fast, that's not always the case with *Expanz! Plus*. For XT and even AT systems, the unit isn't bad, but for

386 and 486i systems, especially those with 16-bit video cards, it's slow.

Part of the speed problem with *Expanz!* comes from the fact that its coprocessor is an 8-bit unit. It's therefore no surprise that it doesn't perform well on higher speed 386 and 486i machines. In fact, *Stacker's* software version will perform better on a high speed machine than *Expanz!*

and its plug-in card.

Another problem with *Expanz!* is that it contains its own 16K memory buffer. The card requires an unoccupied memory address window for this memory. This can cause problems with memory managers such as EMM386 and 16 bit video cards. If your video card uses the same space as *Expanz!*, you'll have to use it in 8-

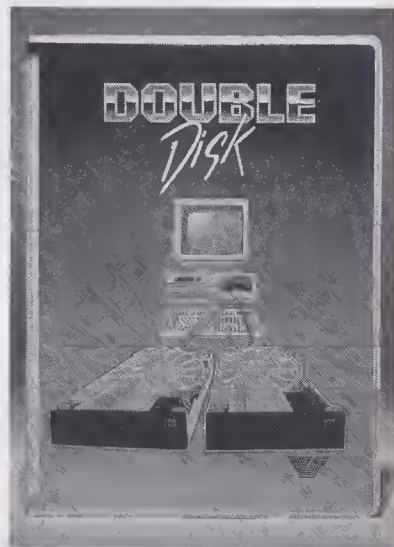
bit mode instead.

In spite of its limitations, *Expanz! Plus* does work, and does double the capacity of your disk drive. And like *Stacker* and *SuperStor*, it will also work on floppy diskettes. The program is compatible with other disk utilities and comes bundled with *Super PC-Kwik*, a caching program to increase speed.

DoubleDisk

DoubleDisk, like *SuperStor*, is a software only compression product. It's primary advantage over *Stacker* and *SuperStor*, is that it's significantly cheaper than both, with a price of only \$99.95. Although its price is low and its performance is good, the program does have some drawbacks. The most important is the lack of a built-in automatic defragmentation and optimization program.

Another drawback of the *DoubleDisk* program is that, unlike both *Stacker* and *SuperStor*, it doesn't allow you to create compressed floppy diskettes. Compressed storage capability is limited to hard disk drives.



In spite of these limitations, however, *DoubleDisk* does do what it promises to—it doubles the size of the allocated storage space—and at a reasonable price. During installation, the program allows you to set aside a designated amount of disk space to be used as a new, compressed disk drive. Up to ten of these extended drives can be added to your system. After asking you how much space you want to allocate, the program creates a new drive that has twice the storage space you allocated.

If you're looking for an inexpensive, no frills, program that can double your disk storage capacity, this is it.

PKZIP

While all the software we've covered so far has been driver software that's transparent to the user and automatically compresses all files saved to the compressed disk, there's another class of compression software that needs to be discussed, the standalone, manually operated, archiving type of software such as *PKZIP*. While it's the most popular software of this type, there are several other products that are similar in nature. Basically, when you use this product you run the program, specify one or more file

names, and *PKZIP* then "zips" up the file(s) and provides a single compressed file with a ZIP extension. To retrieve the files that are stored this way, you must "unzip" them with *PKUNZIP*.

The main difference between this product and all of the others reviewed, is that you can't access, use, or run the zipped files. They must first be unzipped. A handy thing about using *PKZIP* however, is that several files can be zipped up together and transmitted by modem or shipped by disk

to someone else. The recipient then only has to have enough disk space to store the unzipped files and need only type a single command to uncompress all of the files. Because of its easy operation, *PKZIP* and *PKUNZIP* are frequently used by software vendors to distribute their products. It makes installation easy and automatic. *PKZIP* and *PKUNZIP* cost \$47 plus shipping and handling when purchased directly from PKWARE, Inc.

While *PKZIP* doesn't allow you to use files until they are unzipped, that's

not the case for another product called *PKLITE*. *PKLITE* is specially designed to compress executable files

rather than data files. The nice thing about it is that even when compressed, those files can be run, with no appar-

ent decrease in speed. *PKLITE* costs \$46 plus shipping and handling when purchased direct from PKWARE, Inc.

LHA

This software is another archiving file compression type of product, similar in many ways to *PKZIP*. It's a shareware product and, thus, is available for free from a variety of bulletin board systems. The program is used by many software distributors and comes with a small—less than 2K—self-extracting module that lets users without the program uncompress files and use them.

Both *PKZIP* and *LHA* use the same basic compression technique as the transparent disk drivers like *Stacker* and *SuperStor*. They use a compression algorithm known as the Lempel-Ziv algorithm and as a result, they all get similar compression results.

In Conclusion

You should know, by the way, that compressed files can't be further compressed either by running them through the same program or another program using the same algorithm. In fact, attempts to compress already compressed files, will generally yield larger not smaller files.

As you can see, if you're looking to conserve disk space, there are lots of products that can do the job. You just have to decide whether you want to use a hardware or software approach, how much money you want to spend, and whether you want all files compressed automatically, or just some of them manually. ■

Macintosh Compression

AutoDoubler

For the Macintosh, one of the more popular disk compression programs is *AutoDoubler* from Salient Software. Like its PC counterparts, once installed it's completely transparent to the user and operates automatically. Installation on the Mac is a breeze; just click on the installer icon and *AutoDoubler* goes to work.

A nice feature in *AutoDoubler* that's not in its PC counterparts is the ability to tell the program to compress all files that are older than a specified amount of time (hours, days, or even weeks). *AutoDoubler* also has what's known as "fault-tolerant" capa-

bility. In the event of file damage due to a disk crash, the program's repair utility localizes data damage to a single section of the file and repairs as much damage as possible. Data on either side of the section can be completely retrievable. In many cases, the program is able to retrieve the entire file. The program requires Apple's System 6.0.4 or higher and is fully compatible with System 7.0 and the Quadra and PowerBook series of computers. In fact, Apple Canada includes the program in its PowerBook 100 promotion. The best thing about *AutoDoubler* is its price, only \$79.95. □

Companies Featured

AutoDoubler Salient Software

124 University Ave., Suite 300
Palo Alto, CA 94301
(415) 321-5375

DoubleDisk Vertisoft Systems

Route 5, Box 63
Easley, SC 29640
(800) 548-8115

Expanz! Plus InfoChip Systems

2840 San Tomas Expressway
Santa Clara, CA 95051
(800) 447-0200 or (408) 727-0514

PKZIP/PKUNZIP PKWARE, Inc.

9025 N. Deerwood Drive
Brown Deer, WI 53223
(414) 354-8699

Stacker Stac Electronics

5993 Avenida Encinas
Carlsbad, CA 92008
(800) 522-7822 or (619) 431-7474

SuperStor 2.0 AddStor

3905 Bohannon Drive
Menlo Park, CA 94025
(800) 732-3133

Understanding IRQ And DMA Conflicts

The more you know about interrupts and direct memory access, and how they work, the more success you'll have when adding hardware to your PC.

Although they may sound like some new political group, or yet another scheme to stash away money for your retirement, IRQ and DMA are acronyms for the way added hardware can interact with your computer.

Whether you're installing a new expansion board for a local area network, a modem, mouse, scanner, or even a sound card, odds are that you'll encounter IRQ and DMA. And the better you understand what they do, the more success you'll have in getting your system to work—the first time.

Pardon The Interruption

Imagine yourself in a baseball game. You're up at bat. While you're standing there, poised to hit a home run, you're brain is busy making all sorts of calculations—how you're going to hit the ball, what's going to happen

to your team mate who is trying to steal third base, and what the announcer is saying about you.

Here comes the wind-up... The ball now flies toward you at a speed of more than 90 miles per hour. Your eyes see this, and interrupt your brain's train of thought, so that your attention can now be focused on hitting the ball.

Even if you're not playing baseball, your senses act to inform your brain about the world around you. Normally, your brain doesn't spend much of its processing time checking this or that. Instead, it relies on your senses to interrupt your normal train of thought, so that your attention can be focused elsewhere, like the pain of a needle sticking in your pocket, or the smell of a roast cooking in the kitchen.

Computers are designed in much the same way. Rather than spending time checking the condition of all the

various gadgets attached to its circuitry, the microprocessor in your PC ordinarily minds its own business, and virtually ignores any outside stimulus. But interrupt the microprocessor—press a key on the keyboard, for example—and it knows it must momentarily break away from the current job to process new input. In this case, the microprocessor checks the keyboard to see which key you pressed.

The PC architecture supports up to 16 different hardware interrupts; an add-in device of some type, such as a mouse board or modem, can connect to one of these interrupts so that when it needs to get the attention of the microprocessor, it merely sends a signal down a specific wire. (By the way, the PC also supports software interrupts, but these are completely different; we'll address these in a future issue.)

The acronym IRQ comes from in-

errupt request—a device interrupts the regular work flow of the microprocessor, and requests processing time.

The PC & AT Hardware Interrupt Standards

The original IBM PC implemented eight hardware interrupts, as shown in Table 1 (of course, all of the PC compatibles copied this design architecture). Each interrupt shown in the table represents a physical connection in the expansion slots of the PC motherboard. For example, when you add a COM 1 serial port to a PC, most often it uses IRQ4, which just happens to be pin B24 on the expansion slot (each slot on the motherboard has the same connections). When data is received over the serial port, it announces the fact to the microprocessor by sending a pulse down pin B24. (It's as simple as that. Well, sort of.)

As you can see in Table 1, some of the interrupt lines are already taken. The system timer—which controls the clock in your PC, among other things—is permanently connected to IRQ0. The keyboard uses IRQ1; your diskette drives use IRQ6. That leaves, at most, five interrupt lines open.

Now add two serial ports (they should not share the same interrupts, for obvious reasons), a parallel printer port, a mouse, a LAN card, and other goodies—sooner or later there are no more interrupts available.

And if you don't know which interrupts are currently in use, you may unwittingly add a new expansion board that competes with another card in your system. If both boards send an interrupt request at the same time, there's no telling what will happen.

To reduce the chance of competing expansion boards, IBM added an additional eight interrupt lines to the

AT. This system was adopted by the PC-compatible makers, and is still in use today for all PC-based computers, including those with an 386 and 486i microprocessor.

To add the extra interrupt lines the IBM engineers "borrowed" IRQ2 from the original PC design. They simply attached another interrupt controller chip (typically an Intel 8259A) to IRQ2 in a "cascade" or waterfall fashion.

As shown in Table 2, this added IRQ8 through IRQ15, effectively doubling the number of interrupts available. When one of these interrupts is triggered by an expansion board, the microprocessor initially sees it as an interrupt request on IRQ2. Because the request is coming over IRQ2, the microprocessor knows to check the second interrupt controller chip to determine the specific interrupt line that was triggered.

Note IRQ9. Technically, this interrupt line is called the "redirect cascade." This simply means IRQ9 takes the place of IRQ2, which can no longer have any devices directly connected to it. If you have an expansion board that uses IRQ2, you can only use it with an PC or XT-class. It cannot be reliably used with an AT-class (or higher) computer.

Switchable IRQs

When the PC first came out, most manufacturers of expansion boards hard wired the interrupt line to one of the IRQ connectors. That is, the board was permanently designed so that it would use one, and only one, interrupt line.

As the science of expansion board design evolved, manufacturers learned that they could better accommodate the various systems in use by letting you change the interrupt line that's used.

For example, you purchase a serial

port card. More than likely, it will contain one or more DIP switches or jumpers that allow you to select the IRQ you want to use, say IRQ3 or IRQ5. You then choose the interrupt line to use based on the other hardware you have installed. If IRQ3 is already in use, for example, you choose IRQ5.

You also need to worry about IRQs when installing most sound boards, such as a Sound Blaster or Thunderboard. The interrupt line is used to trigger input when recording sounds. The Sound Blaster lets you select from several possible IRQ lines, including IRQ5 and IRQ7. Many users elect IRQ7, even though it's reserved for use by the LPT1 printer port. In actuality, most printers and parallel interface cards don't use IRQ7, and if they do, it's only during printing. Chances are you won't be recording sounds while you're printing!

The Microsoft bus mouse is another good example of an add-in device that lets you change the interrupt line. Rather than indicate the specific IRQ lines, the manual for the Microsoft bus mouse provides a table that details the jumper positions you shouldn't use, depending on your hardware configuration.

For example, if you have an IBM PC/AT or compatible, don't use a jumper in the #2 position. Odds are this jumper is for IRQ2, used for "cascading" to the second interrupt controller chip.

Most owners of AT-class (or higher) computers use IRQ5, which is denoted by jumper #5 on the Microsoft bus mouse card. Although IRQ5 isn't a declared standard for mouse cards, it has become a de facto standard because of its widespread use. Of course, if another device in your PC is already using IRQ5, you'll have to choose another interrupt line.

Bear in mind that expansion cards

don't give you full control over which interrupt line to use. Most often, you can choose between two or three possible interrupts, not all 16 provided in the AT architecture. Therefore, it's not unlikely that you may someday want to install a new expansion card, but find that all the IRQs are already used up, with no alternatives provided. You either have to change the interrupt lines on your existing cards to accommodate the new one, or find another product.

Keeping Track Of IRQs

As you install expansion cards in your PC keep a note of the interrupt lines assigned to each one. Tape the note to the inside cover of your PC (be sure to tape it securely). Then, when you install a new card, you can refer to the note and know exactly which IRQ lines are already taken.

Taking notes isn't always possible, especially if you buy your computer already assembled. The task of determining the IRQ settings of the existing cards can be daunting; fortunately, a number of utility programs are available that automatically detect which

interrupts are in use. The list appears on the screen where you can print it out for future reference.

There are a number of system detection utilities on the market. One of the most popular is *CheckIt!*, published by Touchstone Software. In addition to listing all (or most) IRQs currently in use, *CheckIt!* diagnoses your complete system and warns you of any possible problems, like bad memory chips.

Another system detection utility is Microsoft's *MSD.EXE*. It comes with *Windows 3.1* (although it's a DOS application). *MSD* is primarily designed to help you check the configuration of your computer in case you're having trouble running *Windows*, but of course you can use it to help you install new hardware.

Remember that no system detection program is 100 percent accurate. The nature of IRQs, and the design of some expansion boards, may hide the fact that a particular hardware device is using a given interrupt line. Even though *CheckIt!*, *MSD*, or one of the other system detection utilities may show that an IRQ line is free, in reality it may not be. Be prepared to

do some experimentation.

In Case Of Difficulty

Incorrect IRQ settings are generally easy to spot. At worse, the entire computer locks up, or may not even boot. The latter would occur, for instance, if you set an expansion card to use IRQ14, which is reserved for hard disks on an AT-class (or higher) computer.

Incorrect IRQ settings may also render inoperative one or more less critical devices on your computer. For example, if you recently installed a mouse card, but it conflicts with your COM2 serial port, you may find your mouse either doesn't work at all, or behaves abnormally when using COM2.

To avoid surprises, thoroughly test your PC after installing an expansion card that uses an interrupt line. Exercise each of its parts, including the hard drive, floppies (all of them), mouse, printer, serial port, LAN card, etc. That way, you won't be lulled into thinking everything is working fine, only to be rudely surprised by a glitch a day or so later.

DMA For Efficient Memory Access

DMA stands for Direct Memory Access, which means pretty much what it sounds like. Normally, the microprocessor acts as a go-between when your programs store and retrieve data in your PC's random access memory (RAM). This can understandably lead to a bottleneck in performance. Let's assume you're scanning a full-page image. Even without color or gray shading (black and white only) at 300 dots per inch the page will consume some 8.5 million bits of information. Even a 33 megahertz (MHz) microprocessor will require three to five

seconds to handle this much data. (Data isn't transferred at each clock cycle of the microprocessor, usually every two or four clock cycles.)

Direct memory access allows a device—often a scanner or a sound board, but it can be most anything—to stuff data into your computer's RAM, bypassing the microprocessor. All PC's, including the original to the latest 486s, support DMA memory transfers.

Like IRQs, described above, there are several DMA "channels" in your PCs. Actually, channel isn't the best

term (but it's the one most often used) because the data always takes the same route between the external device and the RAM chips. Rather, the term channel applies to a connector on the expansion slot on the PC's main motherboard.

When an external device wants to feed data into your PC's RAM, it triggers its assigned channel. Only when the microprocessor sends back an acknowledgment can data transfer begin. In this way, your PC isn't bombarded with data coming from all directions at once.

The PC and AT DMA Standards

There are four DMA channels on the original IBM PC (and compatibles). These are labeled DRQ0 through DRQ3. The AT-style (and higher) computers implement an additional four channels of direct memory access, labeled DRQ4 through DRQ7. Table 3 lists the channels and their main uses.

Because of the design of DMA in the PC and AT, there are several limitations that prevent external devices from being merely connected to any of these channels. For example, DMA channel 2 is used to transfer data between RAM and the floppy disk, and this channel should not be shared with any other device. And, on AT-class (and higher) computers, DRQ4 is the "cascade input" for the second set of DMA channels, and is therefore not available on any connectors on the expansion slots inside your computer.

Because of this, most add-in boards that use DMA require channel 1 (DRQ1). Normally, this isn't a problem. However, the devices can't operate at the same time. For example, if you have a scanner and an audio card, and both use DRQ0, scanning an image while you're recording sound will almost certainly cause a

system hang.

For those external devices that can work on alternate DMA channels, the architecture of the PC allows for prioritizing the direct memory access requests. The microprocessor considers channel 0 the highest priority, so it will service the data coming over this channel first. The higher the DRQ number, the lower the priority. If your computer should get two DMA requests at the same time, it will service the one with the higher priority first.

Setting DMA

Many add-in cards for the PC don't offer the flexibility of setting the DMA channel; you either take what they give you, or nothing at all. This isn't necessarily a problem, for many reasons:

- Devices that use DMA aren't common, and are typically limited to image scanners, sound cards, LAN cards, and disk drive controllers. Other add-ins, like a mouse card, parallel port, and serial port, don't typically use DMA.
- Usually (but not always) there's no contention between the devices as long as you don't use them at the same time.

When you can select a DMA channel to use, first try to ascertain if

another device on your computer uses the channel. If so, select another one. Unfortunately, DMA usage is not often reported by system diagnostics programs, like Microsoft's *MSD*.

Proper Software Setup Is a Must

While the selection of the proper DMA channel helps ensure carefree operation, a more common problem when using a device that uses DMA is memory allocation. For example, if you use a scanner, you must set up the scanning software ahead of time so that it allocates (saves space) enough memory to hold the entire image. If the image requires more memory, data in other areas of RAM can be overwritten, and a serious system crash could result.

If you experience sudden system failures (you're using a scanner in *Windows* and suddenly you see the DOS C> prompt, for instance), suspect incorrect software settings.

When in doubt, ask the software to allocate as much memory as practical; the more memory that's reserved for DMA, the less chance of overwriting other data. Exercise caution, however, because as memory is allocated for one task, it's taken away from another. This is especially problematic when using *Windows*. ■

SETTING DIP SWITCHES AND JUMPERS

DIP switches are banks of one or more miniature on/off switches. They are called "DIP" because of their design: "dual in-line package," the same design as an ordinary integrated circuit. The switch levers are very small, and generally must be set using a sharp instrument, such as the tip of a ball-point pen. Push the lever to "On" (or "1") to enable the switch. There's generally no marking for the "Off" setting. (Avoid using a pencil to set DIP switches; the graphite from the pencil can come off and impair the electrical contact inside the switch).

Jumpers serve the same purpose as DIP switches, but because they are cheaper for the manufacturer to implement, they are far more common. The jumper consists of two pins mounted on the circuit board of the hardware. You place a jumper block over the two pins to establish the electrical connection. If you remove the jumper block, the connection is broken.

Use a small pair of needle-nose pliers or blunt tweezers to install and remove jumpers. Be very careful not to bend the connecting pins. They can

be broken off if mistreated.

If you find that you don't have enough jumper blocks for all the jumpers you need to set, you'll have to buy extras. Most electronics stores sell spares at about 10 cents each. If you install lots of hardware, you'll want to keep the extras handy in case you ever need them.

Consult the manual that came with the hardware you're installing to check the settings for the DIP switches and jumpers. You'll find it easier to set the DIP switches and jumpers *before* installing the hardware. □

Know Your IRQs And DMAs

The more you know about interrupts and direct memory access, and how they work, the more success you'll have when adding hardware to your PC.

Before actually installing any new add-on, take the time to check the current IRQ and DMA settings. Check them against the list that you maintain, or with diagnostics software that you run prior to installation. Chances are, you'll avoid 60 to 70 percent of the problems common to installing new hardware, and save yourself time and energy in the process. And, if a problem does occur, you'll be better informed on how to track down its cause and correct it.

Table 1. Hardware Interrupts Used in PC-Class Computers

INTERRUPT NAME	STANDARD FUNCTION
IRQ0	System timer
IRQ1	Keyboard scan
IRQ2	Available
IRQ3	Available
IRQ4	RS-232 serial (COM1)
IRQ5	Available
IRQ6	Diskette drive status
IRQ7	Parallel port (LPT1) status

Table 3. DMA Channels in PC-and AT-Class Computers

CHANNEL	PRIMARY FUNCTION
0	Spare (not available on PC-class)
1	SDLC communications adapter
2	Diskette controller
3	Spare (hard disk in PC-class)
The following on AT-class only:	
4	Controller 1 cascade
5	Spare
6	Spare
7	Spare

Table 2. Hardware Interrupts Used in AT-Class Computers

INTERRUPT NAME	STANDARD FUNCTION
IRQ0	System timer
IRQ1	Keyboard scan
IRQ2	Cascade to secondary interrupt chip (IRQ8 to IRQ15)
IRQ3	Available
IRQ4	RS-232 serial (COM1)
IRQ5	Available
IRQ6	Diskette drive status
IRQ7	Parallel port (LPT1) status
IRQ8	CMOS real-time clock
IRQ9	Replacement for IRQ2
IRQ10	Available
IRQ11	Available
IRQ12	Available
IRQ13	Numeric processor
IRQ14	Hard disk
IRQ15	Available

DISCOUNT PRICE GUIDE

A DIRECTORY OF LOWEST PRICES NATIONWIDE

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The Discount Price Guide staff regularly scans the country for the lowest prices available within each product category. They continually monitor newspaper and magazine advertising and maintain an ongoing phone dialog with outlets across the country. At the last moment before press time, the computer selects the lowest prices for each category. Due to the lead time necessary for the issue to reach the newsstands (several weeks), and the volatile nature of the discount marketplace, prices can fluctuate marginally up or down.

STREET PRICE BUYING TIPS

How to emerge unscathed from the hunt for hardware and software bargains.

Before you buy by mail or phone, you should be armed with information. The following advice should not lead you to believe that you're likely to run into severe problems if you order computer products, hardware, software, and peripherals by phone or mail order. What it is designed to do is protect your interests.

Many companies advertise that they will beat any offer. Low prices, however, are not always what they seem.

Check shipping charges Many companies pass the cost of shipping a package on to the buyer. Shipping rates are based on weight, shipping distance, and insurance to cover the value of the package. The United Parcel Service (UPS), for example, includes insurance for only the first \$100 value of the package within the cost of their regular rates. Each additional \$100 costs an additional 25 cents. If the company you ordered from had to ship a 60-pound dual-page color monitor with a declared value of \$2,500 from New York City to San Francisco, the UPS charge would be approximately \$30.

As you look at our Street Price Guide, remember that it's beside the point to use the Guide to find the lowest price available, only to pay more by using an out-of-state dealer rather than a local supplier.

Sales tax In most states, you are obligated to pay the sales tax in the state in which you reside for an out-of-state purchase. Many states include this in their income tax return form, indicating that you should declare and pay the Use Tax due from an out-of-state purchase.

Know what you are agreeing to Many states hold that you're forming a contract when you place your order. Write down exactly what you want to order before you talk to the dealer and make sure the dealer agrees to provide it. See our buying tips for specific products for more details about what to ask for.

If you've decided to order by mail, write the agreed terms in a letter you send when ordering your system. Time of delivery can be especially important, since some dealers will take your money but not ship your system for weeks.

Tell the dealer you want to receive your system within two weeks, and that you have no interest in buying anything that won't arrive within that time. Your dealer will be in violation of the contract if you don't get exactly what you want under the conditions you want. Point this out to him.

Many dealers provide what they claim is a money-back guarantee if you are not satisfied with their product. However, when you look at the fine print you often discover that your refund is subject to a "restocking" fee that can run as high as 15 percent. Profit margins on some units are as thin as 15 percent, but it's hardly the buyer's obligation to guarantee that a dealer makes a profit—especially when the buyer is dissatisfied with the system shipped.

Tell the dealer you have no intention of paying him to restock equipment that is no good. We're assuming that the system you receive really doesn't function; it would be unethical of you to decide you didn't want a working system and then expect the dealer to take it back without a fee. Read the fine print at the bottom of the advertisements for such disclaimers as, "We do not allow non-defective returns."

Write the dealer a letter as soon as you've ordered the unit. List the specific terms of the contract. This doesn't have to be in legalese. Your letter can simply state that you've ordered a system with certain additions at a specified price; that it must arrive within two weeks; that there is a money-back guarantee within so many days; and that you will not have to pay a restocking fee if the system doesn't work or arrives late. Keep a copy of this letter.

Credit card buying Many experienced buyers pay for the unit with a credit card and tell the dealer to charge their card only when the system is shipped. It can be very difficult to get your money back from the dealer if you paid by check or money order for a bad unit or one that never arrives.

If you ordered the unit on a credit card, you can simply refuse to pay the charges. Some credit card companies will charge you a fee of \$50 for a canceled sale (just as they do with a stolen credit card); however, it's better to be out \$50 than \$1,000.

If the dealer demands payment anyway, tell the credit card company that the dealer contracted with you to deliver your system under certain conditions and then failed to meet these conditions. Tell them that the dealer used your card number without your permission and that you are under no obligation to pay.

You might send them a copy of the letter outlining the agreement you sent to the dealer. If you really believe the dealer is engaged in shady business practices, you might consider complaining to the U.S. Postmaster (if you ordered by mail) and the Federal Trade Commission (FTC).

Check what you've bought When your order arrives, no matter what it is, check it out immediately. When electronic parts fail, they normally do so immediately upon application of power. Those that pass this test still generally fail in the first minutes or hours of use. Your responsibility is to make sure the product works properly while it is still under guarantee.

Despite local and state laws designed to protect the consumer, it is still a case of "Let the Buyer Beware." *Computer Buyers Guide and Handbook* offers the Street Price Guide and the dealer listings only as a guide to what is available and in no way endorses or recommends any of the suppliers listed. ■

HARD DISK DRIVES

MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER	MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER
ESDI											
Maxtor						Kalok					
8760E	675	16	N	\$1,339	Storage Devices Inc.	KL3100	105	25	N	\$289	Storage Devices Inc.
8760E	675	16	N	1,350	JB Technologies	Maxtor					
8760E	675	16	N	1,409	Computer Products Corp.	7040A	40	19	N	195	Storage Devices Inc.
MX4380E	338	16	N	1,150	Ralin Wholesalers	7080A	80	17	N	279	Hard Drives Int'l
MX8380E	360	13	N	1,179	Computer Products Corp.	7080A	80	17	N	299	Computer Products Corp.
MX8380E	360	14	N	1,199	Hard Drives Int'l	7080A	80	19	N	345	JB Technologies
MX8380E	360	14	N	1,199	Storage Devices Inc.	LXT340A	340	13	N	899	DC Drives
Micropolis						LXT340A	340	13	N	1,006	Aberdeen
MC1518	1341	14	Y	2,499	DC Drives	LXT340A	340	13	N	1,025	Ralin Whse.
MC1518	1345	14	N	2,339	Storage Devices Inc.	Quantum					
MC1568	676	16	N	1,221	Shecom Computers	LPS105A	105	12	N	339	Computer Products Corp.
MC1568	676	16	Y	1,379	DC Drives	LPS105A	105	17	N	349	Hard Drives Int'l
MC1664	345	18	N	999	ET Valueline	LPS105A	105	17	N	359	JB Technologies
MC1664	345	14	Y	1,065	DC Drives	LPS52A	52	17	N	199	Storage Devices Inc.
MC1664	345	15	N	1,099	Hard Drives Int'l	LPS52A	52	17	N	209	Hard Drives Int'l
Seagate						LPS52A	52	12	N	219	Computer Products Corp.
ST2182E	160	18	N	849	Storage Devices Inc.	PRO210A	200	15	N	560	American Computing
ST2182E	160	16	N	869	Computer Products Corp.	PRO210A	210	17	N	585	Storage Devices Inc.
ST2383E	330	16	N	1,199	FastMicro	PRO210A	210	17	N	649	Hard Drives Int'l
ST2383E	337	15	N	1,159	DC Drives	Seagate					
ST2383E	338	15	N	1,360	American Computing	ST1239A	210	15	N	540	American Computing
ST766E	660	16	N	1,375	Storage Devices Inc.	ST1239A	210	15	N	549	USA Flex
ST4766E	660	16	N	1,439	DC Drives	ST1239A	210	15	N	599	FastMicro
ST4766E	660	15	N	1,441	Computer Products Corp.	ST2383A	338	16	N	1,119	CMO
IDE						ST2383A	338	16	N	1,159	Computer Products Corp.
Conner						ST2383A	338	16	N	1,159	JDR Microdevices
CP3000	42	25	N	169	Quick Electronics	ST3144A	130	16	N	339	MicroLab
CP3000	42	25	N	189	Hard Drives Int'l	ST3144A	130	16	N	359	USA Flex
CP3000	42	25	N	199	DC Drives	ST3144A	130	16	N	399	JDR Microdevices
CP30104	120	19	N	359	Aberdeen	Western Digital					
CP30104	120	11	N	469	MegaHaus	AC2080	80	15	N	308	Quick Electronics
CP30104	120	19	N	525	Quick Electronics	AC2080	80	15	N	308	Upgrades Int'l
CP3204	209	15	N	525	Storage Devices Inc.	AC2120	120	15	N	364	Quick Electronics
CP3204	209	16	N	609	Hard Drives Int'l.	AC2120	120	18	N	364	Upgrades Int'l
CP3204	210	15	N	549	DC Drives	AC2120	120	18	N	635	American Computing
CP3204	210	16	N	599	Computer Products Corp.	AC2200	212	15	N	599	Quick Electronics
						AP4200	200	15	N	540	American Computing
						AP4200	200	20	N	599	FastMicro
						WD200	210	15	N	595	Shecom Computers

For dealer addresses and phone numbers see page 104 NA denotes not available * For further explanation see Street Price Buying Tips

STREET PRICE GUIDE: HARD DISK DRIVES

MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER	MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER
WD280A	80	20	N	\$290	Shecom Computers	Quantum					
SCSI						LPS105S	105	17	N	\$319	Storage Devices Inc.
Conner						LPS105S	105	17	N	339	Computer Products Corp.
CP30080	84	18	N	279	DC Drives	LPS105S	105	17	N	365	DC Drives
CP30080	84	18	N	325	Storage Devices Inc.	LPS120S	120	15	N	359	Computer Products Corp.
CP30100	104	25	N	379	JB Technologies	LPS120S	120	15	N	375	MegaHaus
CP30100	120	18	N	345	Storage Devices Inc.	LPS120S	120	15	N	419	DC Drives
CP30100	120	18	N	359	DC Drives	LPS52S	43	17	N	239	JB Technologies
CP3540	510	12	N	1,159	Computer Products Corp.	LPS52S	52	17	N	209	Storage Devices Inc.
CP3540	540	12	N	1,199	DC Drives	LPS52S	52	12	N	219	Computer Products Corp.
Fujitsu						PRO210S	210	17	N	639	ComputAbility
M2263S	670	16	N	1,359	Hard Drives Int'l.	PRO210S	210	17	N	639	Storage Devices Inc.
M2263S	672	16	N	1,219	DC Drives	Seagate					
M2263S	688	16	N	1,299	MegaHaus	ST2383N	332	14	N	1,159	DC Drives
M2266S	1079	12	N	1,849	Storage Devices Inc.	ST2383N	332	14	N	1,159	JB Technologies
M2266S	1079	14	N	1,859	DC Drives	ST2383N	332	14	N	1,169	Computer Products Corp.
M2266S	1079	14	N	1,889	MegaHaus	ST296N	85	28	N	239	Storage Devices Inc.
M2622S	330	12	N	1,029	DC Drives	ST41200N	1037	16	N	1,839	Storage Devices Inc.
M2622S	330	12	N	1,025	Storage Devices Inc.	ST41200N	1050	15	N	1,899	Computer Products Corp.
M2622S	330	12	N	1,039	MegaHaus	ST41200N	1200	15	N	1,975	JB Technologies
M2624S	520	12	N	1,149	DC Drives	ST41650N	1420	15	N	2,399	Computer Products Corp.
M2624S	520	12	N	1,149	Quick Electronics	ST41650N	1420	15	N	2,399	Storage Devices Inc.
M2624S	520	12	N	1,159	MegaHaus	ST41650N	1420	15	N	2,479	DC Drives
Imprimis						ST4350N	300	18	N	1,129	Storage Devices Inc.
ST41200N	1037	16	N	2,099	Hard Drives Int'l.	ST4350N	307	16	N	1,159	Computer Products Corp.
ST4376N	340	17	N	1,199	Hard Drives Int'l.	ST4376N	330	18	N	1,099	Storage Devices Inc.
Maxtor						ST4376N	330	17	N	1,129	Computer Products Corp.
MX117S	1470	13	Y	2,499	Hard Drives Int'l.	ST4376N	338	18	N	1,199	JB Technologies
MX117S	1470	13	N	2,499	JB Technologies						
PO 12S	1025	13	N	1,999	Computer Products Corp.						
PO 12S	1059	13	N	1,945	Storage Devices Inc.						
PO 12S	1200	13	N	1,995	JB Technologies						
Micropolis											
MC1528	1341	14	N	1,899	DC Drives						
MC1528	1350	14	N	2,599	Hard Drives Int'l.						
MC1528	1354	15	N	2,359	Quick Electronics						
MC1548	1748	14	N	2,974	DC Drives						
MC1548	1748	14	N	2,975	Storage Devices Inc.						
MC1548	1749	14	N	3,129	MegaHaus						
MC1588	668	16	N	1,274	DC Drives						
MC1588	668	16	N	1,275	Storage Devices Inc.						
MC1588	668	16	N	1,309	Upgrades Int'l.						
MC1598	1049	14	N	1,929	Storage Devices Inc.						
MC1598	1049	14	N	1,939	Quick Electronics						
MC1598	1049	14	N	1,999	Hard Drives Int'l.						
MC1624	665	14	N	1,339	DC Drives						
MC1624	665	14	N	1,342	Quick Electronics						
MC1624	675	14	N	1,288	Aberdeen						

FLOPPY DISK DRIVES

MAKE/ MODEL	MOUNT- ING	STREET PRICE	DEALER	MAKE/ MODEL	MOUNT- ING	STREET PRICE	DEALER
3.5 Double Density				5.25 Double Density			
Chinon	i	\$51	MidWest MicroPeripherals	Chinon	i	\$45	MidWest MicroPeripherals
Sony	i	59	ET Valueline	Chinon	i	50	Nationwide Computer
Sony	i	74	Harmony Computers	Teac	i	57	DC Drives
Teac	i	59	DC Drives	Teac	i	57	Mile Hi Micro
Teac	i	69	CMO	Teac	i	89.95	Jameco Electronic
Toshiba	i	69	Arlington Computer	Toshiba	i	55	MidWest MicroPeripherals
3.5 High Density				Toshiba	i	59	ET Valueline
Chinon	i	50	Jade Computer	Toshiba	i	59	FastMicro
Chinon	i	54	Nationwide Computer	5.25 High Density			
Chinon	i	55.95	Lycy Computer	Chinon	i	56	Nationwide Computer
Chinon	i	58	MidWest MicroPeripherals	Chinon	i	59	ComputAbility
Chinon	i	59	ComputAbility	Chinon	i	59.95	Lycy Computer
Citizen	i	55	MidWest MicroPeripherals	Chinon	i	60	MidWest MicroPeripherals
Epson	i	69	Ralin Whse.	Epson	i	62	Fridays
Ergo	i	49	California MicroChip	Epson	i	69	Ralin Whse.
Ergo	i	49	Mile Hi Micro	Fujitsu	i	56	Aberdeen
Fujitsu	i	56	Aberdeen	Mitsumi	i	50	Asean Computer
Mitsumi	i	47	Amka, Inc.	Mitsumi	i	51	Amka, Inc.
Mitsumi	i	47	Asean Computer	Mitsumi	i	56	Mile Hi Micro
Mitsumi	i	53	Jade Computer	Mitsumi	i	56	Jade Computer
Mitsumi	i	56	Mile Hi Micro	Mitsumi	i	56	Vektron
Mitsumi	i	56	Vektron	Mitsumi	i	58	APLus Computer
Mitsumi	i	58	APLus Computer	Teac	i	56	Amka, Inc.
Sony	i	57	Friday's	Teac	i	59	FastMicro
Sony	i	59	ET Valueline	Teac	i	59	Shecom Computers
Sony	i	59	MidWest MicroPeripherals	Teac	i	60	Telemart
Teac	i	53	Amka, Inc.	Teac	i	61	Nationwide Computer
Teac	i	55	Shecom Computers	Teac	i	62	Mile Hi Micro
Teac	i	57	California MicroChip	Teac	i	63	DC Drives
Teac	i	57	Friday's	Teac	i	64	Essence Group
Teac	i	57	Jade Computer	Teac	i	65	Friday's
Teac	i	59	FastMicro	Teac	i	65	Jade Computer
Teac	i	59	Nationwide Computer	Toshiba	i	57	MicroLab
Teac	i	59	Telemart	Toshiba	i	69	MidWest Computer Works
Teac	i	60	Essence Group	Toshiba	i	69.95	Lycy Computer
Teac	i	62	Mile Hi Micro				
Toshiba	i	56	Telemart				
Toshiba	i	57	MicroLab				
Toshiba	i	59	MidWest MicroPeripherals				
Toshiba	i	64.95	Lycy Computer				
Toshiba	i	69	Arlington Computer				
Toshiba	i	69	MidWest Computer Works				

I = Internal E = External For dealer addresses and phone numbers see page 104

MEMORY UPGRADE

TYPE/ CAPACITY	SPEED (ns)	PRICE	DEALER	TYPE/ CAPACITY	SPEED (ns)	PRICE	DEALER
SIMM				4Mb x 9	80	\$145	MicroTech
1Mb x 8	80	\$39	Hard Drives International	4Mb x 9	80	149	Worldwide Tech.
1Mb x 8	80	39	MicroTech	4Mb x 9	80	169	H.Co. Computer
1Mb x 8	80	43	H.Co. Computer				
1Mb x 8	100	40	Worldwide Tech.	256K x 8	10	17	H.Co. Computer
1Mb x 9	60	38	Shecom	256 x 9	60	13	Micro 911
1Mb x 9	60	40	Micro 911	256 x 9	60	13.65	Worldwide Tech.
1Mb x 9	60	45	Access Computer Components	256K x 9	70	12	Micro 911
1Mb x 9	60	45	MicroTech	256K x 9	70	13	Worldwide Tech.
1Mb x 9	60	46	Worldwide Tech.	256K x 9	70	15	Access Computer Components
1Mb x 9	70	37	Shecom	256K x 9	70	15	Hard Drives International
1Mb x 9	70	38	Micro 911	256K x 9	80	11.50	Micro 911
1Mb x 9	70	42	MicroTech	256K x 9	80	12	H.Co. Computer
1Mb x 9	70	42	Worldwide Tech.	256K x 9	80	12	MicroTech
1Mb x 9	70	44	Hard Drives International	256K x 9	80	12.65	Worldwide Tech.
1Mb x 9	70	46	H.Co. Computer	256K x 9	80	15	H.Co. Computer
1Mb x 9	70	47	Binary Technology	256K x 9	100	9.75	Worldwide Tech.
1Mb x 9	80	36	Shecom	SIPP			
1Mb x 9	80	37	Micro 911	1Mb x 9	60	48	Worldwide Tech.
1Mb x 9	80	40	MicroTech	1Mb x 9	60	54	Binary Technology
1Mb x 9	80	42	Worldwide Tech.	1Mb x 9	70	44	Access Computer Components
1Mb x 9	80	43	Access Computer Components	1Mb x 9	70	44	Worldwide Tech.
1Mb x 9	80	43	H.Co. Computer	1Mb x 9	80	44	Binary Technology
1Mb x 9	80	44	Hard Drives International	1Mb x 9	80	44	Worldwide Tech.
1Mb x 9	100	40	Worldwide Tech.	1Mb x 9	100	42.50	Worldwide Tech.
2Mb x 8	80	109	Hard Drives International	4Mb x 9	60	185	Access Computer Components
4Mb x 8	80	159	H.Co. Computer	4Mb x 9	80	138	Source International
4Mb x 8	80	159	Hard Drives International	4Mb x 9	80	155	Access Computer Components
4Mb x 9	60	145	Shecom	256K x 9	60	14	Storage Devices Inc.
4Mb x 9	60	150	Micro 911	256K x 9	60	16	Worldwide Tech.
4Mb x 9	60	165	Worldwide Tech.	256K x 9	70	15	Worldwide Tech.
4Mb x 9	60	185	MicroTech	256K x 9	80	14	Access Computer Components
4Mb x 9	70	130	Micro 911	256K x 9	80	15	Source International
4Mb x 9	70	130	Shecom	256K x 9	80	14.65	Worldwide Tech.
4Mb x 9	70	149	Worldwide Tech.	256K x 9	100	11.75	Worldwide Tech.
4Mb x 9	70	150	Access Computer Components				
4Mb x 9	70	150	MicroTech				
4Mb x 9	70	169	Hard Drives International				
4Mb x 9	70	170	Binary Technology				
4Mb x 9	80	128	Micro 911				
4Mb x 9	80	130	Shecom				
4Mb x 9	80	139	Storage Devices Inc.				

For dealer addresses and phone numbers see page 104

SOFTWARE

MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER	MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER
OPERATING ENVIRONMENTS				C Compiler 6.0	\$335	\$495	Dustin Discount
Microsoft				Cobol Comp. 3.0	532	900	Software Add Ons
DOS 5.0	\$74.95	\$149.95	ComputAbility	Fortran 5.0	266	450	Telemart
DOS 5.0	79	149.95	Dustin Discount	Fortran 5.0	272	450	Software Add Ons
DOS 5.0 Upgrade	59	99.95	MicroWarehouse	Fortran 5.0	298	450	Loma Computer
DOS 5.0 Upgrade	59	99.95	Telemart	Fortran 5.0	309	450	Dustin Discount
DOS 5.0 Upgrade	69	99.95	Dustin Discount	Macro Assem.	89	195	Telemart
PROGRAMMING LANGUAGES				Macro Assem.	91.95	195	ComputAbility
Borland				Macro Assem.	109	195	Dustin Discount
C++	289	699	FastMicro	Quick Basic 4.5	60	99	Software Unlimited
C++	299.17	699	Computer Discount Whse.	Quick Basic 4.5	69	99	Loma Computer
C++	309	699	Software Unlimited	Quick Basic 4.5	75	99	Dustin Discount
C++	314.95	699	ComputAbility	Quick C 2.5	61.95	99	ComputAbility
Turbo Pascal 6.0	89	149.95	Software Unlimited	Quick C 2.5	67	99	CompuClassics
Turbo Pascal 6.0	93.60	149.95	Computer Discount Whse.	Quick C 2.5	69	99	Loma Computer
Turbo Pascal 6.0	95	149.95	Loma Computer	Quick Pascal	59	99	Software Add Ons
Turbo Pascal 6.0	109	149.95	Dustin Discount	Quick Pascal	60	99	FastMicro
Turbo Pascal Pro	188	299	Software Unlimited	Quick Pascal	61.95	99	ComputAbility
Turbo Pascal Pro	199	299	CompuClassics	Windows Dev.	305	599	Software Add Ons
Turbo Pascal Win.	121	279	Loma Computer	Windows Dev.	309	599	FastMicro
Turbo Pascal Win.	125	279	CompuClassics	Owl International			
Turbo Pascal Win.	169	279	Dustin Discount	Guide 3	379	495	Laser Press & Graphics
Turbo Pascal Win.	169	279	Insight Software	Guide 3	389	495	Dustin Discount
Turbo Pro	109	299	Dustin Discount	STSC			
DigiTalk				APL Plus	439	695	Software Add Ons
SmallTalk V Wind.	289	499	Software Add Ons	Solution Systems			
SmallTalk V Wind.	308	499	PC Zone	Brief	168	249	Loma Computer
SmallTalk V286	125	199.95	Dustin Discount	Brief	185	249	Dustin Discount
SmallTalk V286	138	199.95	PC Zone	Brief	187	249	Star Ware
SmallTalk VPM	299	499.95	Dustin Discount	WhiteWater			
SmallTalk Wind.	279	499	Dustin Discount	Actor Pro	316	595	Star Ware
SmallTalk Wind.	319	499	CompuClassics	Actor Pro	318	595	Loma Computer
Knowledge Garaden				Actor Pro	329	595	Dustin Discount
Knowledge Pro	184	299	PC Zone	Actor Pro	349	595	Software Add Ons
Knowledge Pro Gold	399	699	PC Zone	UTILITY PROGRAMS			
Microsoft				MicroLogic Software			
Basic Pro Dev.	293	495	Telemart	InfoSpotter	44	99	Software Unlimited
Basic Pro Dev.	298	495	Software Unlimited	InfoSpotter	44.95	99	ComputAbility
Basic Pro Dev.	314.95	495	ComputAbility	InfoSpotter	59	99	Insight Software
C Compiler 6.0	299	495	CallSoft	A.I. Solutions			
C Compiler 6.0	329	495	CompuClassics	PC IQ	58	129	PC Zone
				Abacus			
				BeckerTools	69	139	Software Add Ons
				BeckerTools	79	139	Dustin Discount

For dealer addresses and phone numbers see page 104

STREET PRICE GUIDE: SOFTWARE

MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER	MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER
BeckerTools	\$79	\$139	Publishing Perfection	Dariana Technology			
Above Software				SystemSleuth Pro	\$99	\$149	CompuClassics
Above Disk	54	120	Software Add Ons	WinSleuth	95	149	Software Add Ons
Above Disk	56	120	SoftComp USA	WinSleuth	99	149	Publisher's Toolbox
Above Disk	65	120	Dustin Discount	WinSleuth	105	149	MicroWarehouse
AddStor				Delta Technology			
SuperStor	75.95	139	ComputAbility	Direct Access	59	89.95	Software Unlimited
SuperStor	83	139	PC Connection	Direct Access	59	89.95	Telemart
SuperStor	85	139	MicroWarehouse	Direct Access	59.95	89.95	ComputAbility
Ashton Tate (Borland)				Direct Access	69	89.95	Dustin Discount
Control Room	69	129	FastMicro	Direct Net	147	395	Star Ware
Control Room	89	129	Dustin Discount	Fifth Generation			
Asymetrix				FastBack+	110	189.95	CallSoft
Toolbook	277	395	Publishing Perfection	FastBack+	115	189.95	Star Ware
Toolbook	279	395	FastMicro	FastBack+	119	189.95	Dustin Discount
Atech/M				FastBack+	122	189.95	CompuClassics
Pub's PowerPak	39	79.95	Publishing Perfection	Mace 1990	89.80	149	Computer Discount Whse.
Pub's PowerPak	45	79.95	FastMicro	Mace 1990	92	149	Software Add Ons
Attitash				Suitcase II	53	79	Publisher's Toolbox
AttiTools	62	129.95	PC Connection	Funk Software			
AttiTools	82	129.95	MicroWarehouse	Allways 1.2	109	195	Software Add Ons
AttiTools	95	129.95	Dustin Discount	Allways 1.2	115	195	Software Unlimited
Dragnet	32	79	PC Connection	Allways 1.2	129	195	Dustin Discount
Dragnet	34	79	PC Zone	Sideways 3.3	54	69.95	Telemart
WideAngle	62	129	PC Connection	Sideways 3.3	55	69.95	FastMicro
WideAngle	75	129	FastMicro	Sideways 3.3	64	69.95	Software Unlimited
WideAngle	85	129	Dustin Discount	Sideways 3.3	65	69.95	Dustin Discount
Berkeley Systems				Gazelle			
AfterDark	28.95	49.95	ComputAbility	OPTune	42	99.95	Telemart
AfterDark	29	49.95	MicroWarehouse	OPTune	45	99.95	Software Add Ons
AfterDark	31	49.95	Publisher's Toolbox	OPTune	55	99.95	Dustin Discount
Bloc Publishing				Gibson Research			
PopDrop+	53	99.95	FastMicro	SpinRite II	58.95	89	ComputAbility
Borland				SpinRite II	62	89	Insight Software
ObjectVision	94.95	149	ComputAbility	SpinRite II	64	89	CompuClassics
ObjectVision	97	149	Star Ware	SpinRite II	68.95	89	Loma Computer
ObjectVision	109	149	Dustin Discount	Gold Disc			
SideKick	53	129	FastMicro	ScreenCraze	28	49.95	PC Zone
SideKick	55	129	Star Ware	ScreenCraze	28.95	49.95	ComputAbility
SideKick	59	129	Loma Computer	ScreenCraze	29	49.95	MicroWarehouse
Bourbaki				hDC			
1 Dir+	44	95	SoftComp USA	1st Apps	48	99.95	SoftComp USA
1 Dir+	46.95	95	ComutAbility	1st Apps	52	99.95	Publishing Perfection
Central Point				1st Apps	55	99.95	FastMicro
AntiVirus	78	129	Loma Computer	1st Apps	59	99.95	Dustin Discount
AntiVirus	79	129	PC Connection	Icon Designer	32	59	Software Add Ons
AntiVirus	85	129	MicroWarehouse	Icon Designer	33	59	PC Zone
Copy II PC	30	69.95	Insight Software	Icon Designer	45	59	Dustin Discount
Copy II PC	33	69.95	Telemart	Windows Express	52	99.95	Publishing Perfection
Copy II PC	35	69.96	Dustin Discount	Windows Express	55	99.95	FastMicro
PC Tools	94.43	179	Software Unlimited	Windows Express	65	99.95	Dustin Discount
PC Tools	102	179	CallSoft	Helix			
PC Tools	109	179	PC Connection	HeadRoom	61.95	129	ComputAbility
PC Tools	119	179	MicroWarehouse	HeadRoom	63	129	Star Ware
PCTools LAN	785	1,299	CallSoft				

STREET PRICE GUIDE: SOFTWARE

MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER	MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER
HeadRoom	\$65	\$129	Loma Computer	Novell			
NetRoom	59	79	MicroWarehouse	NetWare Lite	\$69	\$139	PC Connection
NetRoom	59.95	79	ComputAbility	Okna Corporation			
NetRoom	65	79	PC Connection	DeskTop Set	36.48	149	Computer Discount Whse.
NetRoom	69	79	Dustin Discount	DeskTop Set	59	149	Publishing Perfection
NetRoom LAN50	349.95	379	ComputAbility	DeskTop Set	79	149	PC Connection
IBM				Personics			
Current 1.1	209	395	FastMicro	Laptop Ultravision	41.95	89	ComputAbility
Current 1.1	212	395	Loma Computer	Laptop Ultravision	49	89	CompuClassics
Current 1.1	219	395	Software Add Ons	Laptop Ultravision	59	89	PC Connection
ICOM Simulations				UltraVision	59	119	PC Connection
Intermission	28.95	49.95	ComputAbility	UltraVision	69.95	129	ComputAbility
Intermission	29	49.95	PC Connection	UltraVision	77	129	Star Ware
Intermission	30	49.95	Insight Software	Ultravision	69.95	119	ComputAbility
Squeegee Windows	42	79	PC Connection	Peter Norton (Symantec)			
Laser Tools				AntiVirus	81.95	129	ComputAbility
PrintCache	87.95	129	ComputAbility	AntiVirus	85	129	Publisher's Toolbox
PrintCache	98	129	Publishing Perfection	AntiVirus	85	129	Star Ware
PrintCache	99	129	Publisher's Toolbox	AntiVirus	89	129	Dustin Discount
LaserGo				BackUp	85	129	FastMicro
GoScript	85	149	Software Add Ons	BackUp	89	129	Software Unlimited
GoScript	89	149	FastMicro	BackUp	93	129	Star Ware
GoScript+	172	299	Software Add Ons	Desktop Windows	92	149	Ralin Wholesalers
Lotus Development				Desktop Windows	92	149	Software Unlimited
Magellan	94.10	139	Computer Discount Whse.	Desktop Windows	95	149	Insight Software
Magellan	97	139	Software Add Ons	Utilities	105	159	Telemart
Magellan	115	139	Dustin Discount	Utilities	107	159	Software Add Ons
Magee Enterprises				Utilities	115	159	CompuClassics
AutoMenu 4.5	35	69.95	Telemart	Polaris			
AutoMenu 4.5	39	69.95	Star Ware	PackRat	229.95	395	ComputAbility
AutoMenu 4.5	45	69.95	Dustin Discount	PackRat	255	395	Dustin Discount
Merrill & Bryan				PackRat	259	395	MicroWarehouse
Turbo EMS	48.95	99.95	ComputAbility	Prime Solutions			
Turbo EMS	52	99.95	Software Add Ons	Disk Tech Gold	89	149.95	Software Add Ons
Turbo EMS	59	99.95	Dustin Discount	Disk Tech Gold	99	149.95	Dustin Discount
Metro ImageBase				QMS			
LaserTwin	117	179	Publishing Perfection	UltraScript PC	105	295	Software Add Ons
MicroCom				UltraScript PC	118	295	Publishing Perfection
CarbonCopy+	107	139	Software Unlimited	UltraScript PC	125	295	Publisher's Toolbox
CarbonCopy+	109	139	Insight Software	UltraScript PC+	229	445	Software Add Ons
Virex PC	65	129	Insight Software	UltraScript PC+	259	445	Publishing Perfection
Virex PC	73	129	SoftComp USA	UltraScript PC+	263	445	Publisher's Toolbox
Virex PC	85	129	Dustin Discount	Qualitas			
MicroLogic Software				386 Max	61	99.95	MicroWarehouse
InfoSelect	79.95	149	ComputAbility	386 Max	64	99.95	Software Unlimited
InfoSelect	86	149	Software Unlimited	386 Max	67	99.95	Software Add Ons
InfoSelect	87	149	Telemart	Blue Max	79	124.95	PC Connection
Microcom				Blue Max	85	124.95	Dustin Discount
CarbonCopy+	117	195	Loma Computer	Blue Max	87	124.95	Star Ware
CarbonCopy+	119	195	PC Connection	Quarterdeck			
Microlytics				DeskView 386	124.95	219.50	ComputAbility
GOfer 2.0	42	79.95	Software Add Ons	DeskView 386	125	219.50	Software Add Ons
Microsoft				DeskView 386	139	219.50	Dustin Discount
Windows 3.0	87	129	Software Add Ons	DesqView II	73	129.95	Software Add Ons
Windows 3.0	88.95	129	ComputAbility	DesqView II	75	129.95	FastMicro
Windows 3.0	89	129	FastMicro				

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MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER	MANUFACTURER/ PRODUCT	STREET PRICE	LIST PRICE	DEALER
DesqView II	\$85	\$129.95	Dustin Discount	Language Master	\$49	\$99	Software Add Ons
QEMM 386	60	99.95	CallSoft	IBM			
QEMM 386	62	99.95	CompuClassics	DisplayWrite V	235	495	Software Add Ons
QEMM 386	65	99.95	Dustin Discount	DisplayWrite V	235.50	495	Computer Discount Whse.
GRAM	49	79	Star Ware	Writing Asst.	75	139	Software Add Ons
GRAM	52	79	Loma Computer	Writing Asst.	87	139	Star Ware
GRAM	57	79	Telemart	Lotus Development			
Revolution Software				Manuscript	309.79	495	Computer Discount Whse.
VGA Dimmer	22	79	Software Add Ons	Manuscript	339	495	Dustin Discount
VGA Dimmer	24	79	Star Ware	Microsoft			
SoftLogic Solutions				Word 5.5	\$199.90	\$450	Computer Discount Whse.
Disk Optimizer	29	69.95	Software Add Ons	Word 5.5	202	450	Software Add Ons
Software Carousel	53	89.95	Software Add Ons	Word Windows	298	495	Software Unlimited
Software Carousel	55	89.95	Star Ware	Word Windows	299	495	Publishing Perfection
Software Carousel	59	89.95	Loma Computer	Monogram			
Software Directions				Word for Word	\$74	\$159	PC Zone
PrintQ	79	149	Telemart	Word for Word	79	159	Star Ware
PrintQ	80	149	Software Add Ons	Reference Software			
PrintQ	85	149	MicroWarehouse	Grammatik	54	99	Insight Software
PrintQ	86	149	Loma Computer	Grammatik	55	99	FastMicro
Stac Electronics				Samna			
Stacker	79	129	Insight Software	Ami Pro	279	495	Insight Software
Stacker	85	129	PC Connection	Ami Pro	288	495	Loma Computer
Stacker	89	129	CallSoft	Ami Upgrade	89	199	Software Add Ons
Systems Compatibility				Ami Upgrade	99	199	Dustin Discount
Software Bridge	69	129	Star Ware	Software Publishing			
Software Bridge	69.95	129	ComputAbility	OfficeWriter	224	395	Loma Computer
Touchstone Software				OfficeWriter	234	395	PC Zone
Check It	77.95	149	ComputAbility	PFS ProWrite	146	259	PC Zone
Check It	79	149	Insight Software	PFS ProWrite	159	259	FastMicro
Travelling Software				Symantec			
Battery Watch	27	49.95	Software Add Ons	JustWrite	75	199	FastMicro
Battery Watch	29	49.95	Software Unlimited	JustWrite	129	199	MicroWarehouse
Battery Watch	32	49.95	Star Ware	Systems Compatibility			
White Crane Systems				Writer's Toolkit	77.95	129	ComputAbility
Brooklyn Bridge	83	129	SoftComp USA	Writer's Toolkit	79	129	PC Zone
Brooklyn Bridge	85	129	Insight Software	WordPerfect			
XTree				WordPerfect 5.1	239	495	PC Zone
XTree Gold	85	149	Star Ware	WordPerfect 5.1	249	495	FastMicro
XTree Gold	92	149	Telemart	WordPerfect 5.1	258	495	Publishing Perfection
XTree Gold	99	149	Dustin Discount	WordScience			
Zenographics				Definitions Plus!	57	129	Software Add Ons
SuperPrint HP	112	195	Software Add Ons	Definitions Plus!	64	129	Loma Computer
SuperPrint HP	113	195	PC Zone	WordStar			
WORDPROCESSING PROGRAMS				Correct Grammar	53.95	99	ComputAbility
ZyIndex				Correct Grammar	54	99	PC Zone
ZyIndex	235.95	495	ComputAbility	Correct Grammar	57	99	FastMicro
ZyIndex	269	495	Software Add Ons	Legacy	259	595	Software Add Ons
Ashton Tate (Borland)				Legacy	273	595	Loma Computer
MultiMate 4.0	235	565	Ralin Wholesalers	WordStar 6.0	225	495	Dustin Discount
MultiMate 4.0	239	565	FastMicro	WordStar 6.0	273	495	Loma Computer
Avery Dennison				XYQuest			
Label Pro	49	99.95	PC Connection	XYWrite III+	197	295	Telemart
Label Pro	54	99.95	Publishing Perfection	XYWrite III+	207	295	SoftComp USA
Franklin Software							
Language Master	44	99	PC Zone				

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398 Lemon Creek Dr., Unit H,
Walnut, CA 91789, Phone: (800)
443-5373, (714) 594-1112

Aberdeen

1125 S. Maple Ave., Unit P,
Montebello, CA 90640, Phone:
(800) 552-6868, (213) 725-3368

Access Computer Technology

2225 El Camino Real, Santa
Clara, CA 95050, Phone: (800)
359-6800, (408) 247-4444

American Computer Discounters

3100 Clarendon Blvd., Arlington,
VA 22201, Phone: (800) 533-
4604, (813) 309-6058

American Computing Tech.

4124 Rosemead Blvd., #A,
Rosemead, CA 91770, Phone:
(800) 638-6698, (818) 309-6058

Amka, Inc.

15342-B E. Valley Blvd.,
City of Industry, CA 91746, Phone:
(818) 369-2121

Arlington Computer Products

1970 Carboy, Mt. Prospect, IL
60056, Phone: (800) 548-5105,
(708) 228-6333

Asean Computer

971 Fairway Dr., Walnut, CA
91789, Phone: (714) 598-2828

Atlantic Computer Systems

171 Rt. 37E & Hooper Ave.,
Toms River, NJ 08753, Phone:
(800) 628-0046, (908) 240-3101

Ballard Computer

5424 Ballard Ave. NW, Seattle,
WA 98107, Phone: (781) 7000

Binary Technology

2657 Beltline, Carrollton, TX
75006, Phone: (800) 776-7990,
(214) 417-0777

Bulldog Computer Products

610 Industrial Park Dr., Evans, GA
30809, Phone: (800) 438-6039,
(404) 860-7364

Business Computer Systems

2216 Commerce Parkway,
Virginia Beach, VA 23454, Phone:
(800) 33-FAX55

CAD & Graphics

1301 Evans, San Francisco, CA
94104, Phone: (800) 288-1611,
(415) 647-9671

CMO Corp.

101 Reighard Ave., Williamsport,
PA 17701, Phone: (800) 233-
8950, (717) 327-9200

California Microchip

9240 Deering Ave., Chatsworth,
CA 91311, Phone: (800) PRO-
CHIP, (818) 884-3660

CallSoft

2 Riverview Dr., Somerset, NJ
08873, Phone: (800) 777-5014

Circuit City

4400 Sunset Blvd., Los Angeles,
CA 90028, Phone: (213) 663-6033

Circuit City

5959 Alpha Rd., Dallas, TX 75240,
Phone: (214) 991-3122

Circuit City

1608 Sweetwater Rd., San Diego,
CA 91950, Phone: (619) 477-0093

CompUSA

6527 Jimmy Carter Blvd.,
Norcross, GA 30093, Phone: (404)
441-3300

CompUSA

12230 Westheimer #60, Houston,
TX, Phone: (713) 589-0215

CompUSA

1250 El Camino Real, San Bruno,
CA 94066, Phone: (415) 244-9990

Compu\$ave

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Phoenix, AZ 85040, Phone: (800)
544-8302, (602) 437-8298

CompuAdd

12303 Technology Blvd., Austin,
TX 78727, Phone: (800) 456-3660

CompuAdd

6100 Westheimer, Houston, TX
77057, Phone: (713) 894-0785

CompuD

6741 Van Nuys Blvd., Van Nuys,
CA 91405, Phone: (818) 787-
3282, (818) 781-7888

ComputAbility

PO Box 17882, Milwaukee, WI
53217, Phone: (800) 558-0003,
(414) 357-8181

Computer Attic

2750 El Camino Real, Redwood
City, CA 94061, Phone: (415) 363-
8100

Computer Clipboard

8309 Linden Oaks Court, Lorton,
VA 22079, Phone: (800) 777-4932

Computer Discount Warehouse

2840 Maria, Northbrook, IL 60062,
Phone: (800) 233-4426, (708) 498-
1426

Computer Input Products

1301 Evans Ave., San Francisco,
CA 94124, Phone: (800) 825-
1187, (415) 647-2684

Computer Products Corp.

1431 S. Cherryvale Rd., Boulder,
CO 80303, Phone: (800) 338-4273

Computer Town

304 S. Broadway, Salem, NH
03079, Phone: (800) 666-0004

Computown

2444 Old Middlefield Way,
Mountain View, CA 94043, Phone:
(415) 962-8696

Cycad Micosystems

121 E. Brokaw Rd., San Jose, CA
95112, Phone: (408) 436-4843

DAAC Computer Corp.

123 W. 28th St., New York, NY
10001, Phone: (800) 992-3007,
(212) 967-8252

DC Drives

1110 NASA Rd., 1, Ste. 304,
Nassau Bay, TX 77058, Phone:
(800) 872-6007, (713) 333-9602

Dustin Discount

20969 Ventura Blvd., Ste. 13,
Woodland Hills, CA 91364, Phone:
(800) 274-6611, (818) 710-9174

ET Valueline

7350 N. Linder Ave., Skokie, IL
60077, Phone: (800) 395-1000,
(708) 677-7660

Electrified Discounters

1066 Sherman Ave., Hamden, CT
06514, Phone: (800) 678-8585,
(203) 287-1976

Essence Group

17815 Newhope St., #G,
Fountain Valley, CA 92708,
Phone: (714) 546-3110, (714) 546-
3110

Exsel, Inc.

2200 Brithton-Henrietta Rd.,
Rochester, NY 14623, Phone:
(800) 624-2001, (716) 272-8770

FastMicro

4405 E. Baseline Rd., Phoenix, AZ
85044, Phone: (800) 441-3278,
(602) 431-3278

Focus Computer

1303 46th St., Brooklyn, NY
11219, Phone: (800) 223-3411,
(718) 436-4646

Friday's

980 S. First St., San Jose, CA
95110, Phone: (800) 488-6575

Fry's Electronics

440 Mission Ct., Fremont, CA
93711, Phone: (510) 770-3797

H.Co. Computer

17922 Sky Park Circle, #F, Irvine,
CA 92714, Phone: (800) 726-
2477, (714) 833-3222

Hard Drives International

1912 W. 4th St. Dept. HDU,
Tempe, AZ 85281, Phone: (800)
767-DISK, (800) 733-0882

Harmony Computers

1801 Flatbush Ave., Brooklyn, NY
11210, Phone: (800) 441-1144,
(718) 692-3232

Hi Tech USA

1562 Centre Point Dr., Milpitas,
CA 95035, Phone: (800) 831-
2888, (800) 831-2780

Insight Computers

1912 W. 4th St., Tempe, AZ
85281, Phone: (800) 776-7600,
(602) 350-1176

J&R Computer World

15 Park Row, New York, NY
10038, Phone: (800) 221-8180,
(212) 732-8600

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5105 Maureen Lane, Moorpark,
CA 93021, Phone: (805) 529-0908

JDR Microdevices

2233 Samaritan Dr., San Jose, CA
95124-9923, Phone: (800) 538-
5000

Jade Computer

4901 W. Rosecrans Ave.,
Hawthorne, CA 90251-5046,
Phone: (800) 421-5500, (310) 973-
7707

Jameco Electronics

1355 Shoreway Rd., Belmont, CA
94002, Phone: (800) 831-4242,
(415) 592-8097

Kenosha Computer

2133 91st St., Kenosha, WI
53140, Phone: (800) 255-2989,
(414) 697-9595

Laser Press & Graphics

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MD, 20748, Phone: (800) 628-
4517, (301) 899-1118

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2846, (213) 798-2835

Lycor Computer

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17740, Phone: (800) 233-8760,
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Houston, TX 77058, Phone: (800)
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Virginia Beach, VA 23454, Phone:
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Stamford, CT 06907, Phone: (203)
967-3435)

Micro 911, Inc.

35526 Grand River, Ste. 343,
Farmington Hills, MI 48335-3120,
(313) 474-1300, (800) 886-0911

MicroLab

23976 Freeway Park Dr.,
Farmington Hills, MI 48335, Phone:
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MicroProfessionals

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Lansing, IL 60438, Phone: (800)
800-8300

MicroTech

7304 15th Ave., NE, Seattle, WA
98115, Phone: (800) 521-9035,
(206) 526-7989

MicroUSA

11836 Pico Blvd., Los Angeles,
CA 90064, Phone: (800) 227-
6888, (213) 473-2535

MicroWarehouse

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08701-3014, Phone: (800) 367-
7080, (908) 370-0518

Microcomputer Publishing

4 W. 20th St., New York, NY
10011, Phone: (212) 463-8585

MidWest Computer Works

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IL 60089, Phone: (800) 669-5208

MidWest MicroPeripherals

6910 US Rte. 36 East, Fletcher,
OH 45326, Phone: (800) 423-
8215, (513) 368-2650

Mile Hi Micro

10525 East 40th Ave. #203,
Denver, CO 8239, Phone: (800)
800-9828, (303) 375-1440

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San Jose, CA 95131, Phone:
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Phone: (800) 243-8088, (603) 446-
7721

PC Zone

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Redmond, WA 98052, Phone:
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85282, Phone: (800) 969-1722,
(602) 968-7992

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0312, Phone: (800) 348-4727

Penta Computer

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53705, Phone: (800) 233-3898

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WI 53051, Phone: (800) 782-
5974, (414) 255-7600

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Software Add Ons

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Bensalem, PA 19020, Phone:
(800) 822-8088, (215) 639-7110

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2465 W. 12th St., Ste. 5, Tempe,
AZ 85281, Phone: (800) 926-
SOFT, (800) 926-7638

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Viejo, CA 92656, Phone: (800)
535-5892, (714) 588-9866

Star Ware

3174 Sunset Ave., Norristown, PA
19403, Phone: (800) 523-0702

Telemart

8804 N. 23rd Ave., Phoenix, AZ
85021, Phone: (800) 537-4735

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1310 Carroll St., Kenner, LA
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(504) 468-2113

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5306 Beethoven Ave., Los An-
geles, CA 90066, Phone: (800)
338-0939, (213) 301-0300

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160 Broadway, New York, NY
10038, Phone: (800) 433-5199,
(212) 349-3134

USA Flex

135 N. Brandon Dr., Glen Ellyn, IL
60139, Phone: (800) USA-FLEX,
(800) 872-3539

UnderWare Electronics

7761 W. Kellog, Wichita, KS
67209, Phone: (800) 442-1408,
(316) 721-2600

Vektron

2100 N. Hwy. 360, Ste. 1904,
Grand Prairie, TX 75050, Phone:
(214) 606-0280

Wholesale Discount Club

80 Ponds Edge Dr., Chaddsford,
PA 19317, Phone: (800) 765-
5287, (215) 388-1316

WorldWide Technology

21 South 5th St., Philadelphia, PA
19106, Phone: (800) 457-6937,
(215) 922-0050



Practical PostScript Applications

Use PostScript to Prepare Business Reply Cards and Meet the Post Office's Exacting Standards

Direct mail marketing is a very effective way to sell almost any product. One of the ways to increase response from a direct mail campaign is to provide your potential customer with an easy way to reply to your offer. Extensive research into direct mail marketing techniques has shown that requiring your potential customer to put a stamp on a postcard or envelope will significantly decrease your response. For that reason, most direct mail marketers offer a postage-paid way for their customers to respond—Business Reply Mail (BRM).

With Business Reply Mail, a permit is purchased from the post office for a nominal annual fee, which allows you to produce cards, envelopes, or labels that can be sent through the mail without any stamps. You can print thousands of these and only have to pay for those you receive, which presumably will contain orders for your product. To take advantage of this handy reply mechanism, however, the Post Office requires you to follow some very strict rules about the placement of the various components that make up the Business Reply Mail piece. For example, the bar code on the piece must be in a certain location within a fairly small tolerance, the horizontal bars on the right side of the piece must have a certain position relative to the return address, and a variety of other things are also necessary. If any one of these

things are incorrect, your Business Reply Mail piece can be rejected by the Post Office.

With the PostScript program provided here, you can forget about all of these potential problems and not even need to hire an artist to make up a mechanical for you. The output of the program, is a ready-to-use original that complies with all of the Post Office's rules of placement. Of course, you should always use the free template the Post Office provides to double check it, but the master that's produced should meet all current requirements. When using the program, all you have to do is enter the permit number that was assigned to you by the Post Office, the city and state associated with that permit number, and your return address. Frequently, the Post Office will require you to place a special four-digit extension on the ZIP+4 code. For example, if your normal ZIP+4 code is 11214-1803, the Post Office may require you to change it to 11214-9990. The 9990 is a code that is used by the Post Office's automatic sorting equipment to properly route and keep track of the number of BRM pieces you received (remember you pay for each piece you get).

Looking at the Program

While there are several Business Reply Mail formats that can be used, this program specifically designs a

postcard (see Figure 1.). The standard size that's used for a postcard in card decks is 3.5-by-5.375 inches, so that's what's used here. By the way, in the last two programs, all the measurements that were used were in points (1 point is 1/72nd of an inch). In this program, I've defined a new command called **inch** which multiplies the number that precedes it by 72 so that we can work in inches for convenience.

To refresh your memory, or for those of you who missed the previous articles on PostScript, when the PostScript interpreter encounters data, the first thing it does is to automatically push that data onto a memory stack to temporarily store it until it's needed. This stack works like the spring-loaded dish stackers in a cafeteria. As a new dish is added, the stack is pushed down to make room for it and as a dish is taken away, the stack pops up to make another dish available.

Looking at the program listing, you can see that the first thing that the program does is take the user-supplied data (permit number, city, state, and return address) and push it onto the stack for temporary storage. It first encounters the text string "125", which is the permit number, and puts it on the stack. The "125" is recognized as text and not as a number because it's located within parentheses—if we took those away,

PostScript would treat the "125" as a number. Next, the program encounters "BROOKLYN, NY", another string of text that's temporarily placed on the stack until it's needed. This continues until all of the user-supplied data is stored.

Defining Subroutines

Many of the things that you'll do in PostScript will be repetitive, tasks you'll perform again and again. Instead of having to program them from scratch each time, use a library of subroutines. The first part of this issue's program defines the subroutines that we're going to need. You ought to save these to a separate file and use them in your own programs.

The first routine, called "right", right justifies text. It starts at the current location of the cursor and places type to the left of it. The last character in the string being printed will be located at the current cursor position. The next routine is one that we used last time. It centers text around the current position of the cursor.

Routines to center and right justify text are fairly common and can be found in most books on PostScript programming. The following routine, however, "mergestr", will not be found in most of these sources, so make sure you hang on to it. Basically, this routine takes strings of text and combines them into one. It's useful, as we use it here, to combine fixed text (PERMIT NO.) with text that can change (e.g., the actual number 125) and then treat the resulting entity as a single string.

The next routine that's defined is the one that converts inches to points. Then comes a series of routines that prints the cropmarks. Each of the four cropmarks has its own designation. Notice how long and descriptive the names are. That's a big benefit of PostScript, it doesn't care how

long variable or subroutine names are. The last two subroutines that are defined are the ones that print the bar codes on the post card. The Post Office assigns you one of these two types for use on your BRM piece.

Getting Down to Business

Now that we've assembled our tools (defined our subroutines), we're ready to get to work. This is where our program actually starts to do something. The first task is to take all that user-supplied data that was temporarily stored on the stack and assign it to variables. Because PostScript is a stack-oriented language, the data that was entered last is the data that's available first. Thus, the first piece of data that we pull off the stack is going to be the last line of the return address. Data is assigned to a variable by using a slash (/) in front of the variable name to tell PostScript that you're defining a command or assigning data to a variable, and then using the *exch* command. You finish off by using the word "def" to tell PostScript that the end of the definition has been reached.

After assigning the data to its variable, the line width is set to 0.7 points in width and the cropmarks for the card are drawn. Next, the box that contains the words "BUSINESS REPLY MAIL" is drawn. After that, the stamp block, that says no postage is needed if the piece is mailed in the U.S., is drawn. Then, the appropriate bar code is drawn. The commands for drawing both bar codes are supplied, but only one should be used. The other one should be preceded, on the same line, with a percent sign (%) which turns the command into a comment that's ignored by the PostScript interpreter. The final graphic element drawn is the series of horizontal bars on the right side of the mailing piece.

Now that all of the graphic ele-

ments have been properly placed, the text needed for the piece can be added. Most of this is straight-forward. A type font and size are selected, the cursor is moved to the appropriate position, justification is performed if required, and the text is printed with the *show* command. In cases where you have several consecutive lines of text, positioning the cursor for each line can get tedious, so why not use the computer to eliminate the tedium? That's exactly what I did at the end of the program where the text for the stamp block and the return address are placed. In each case, the starting location was defined as "xpos" and "ypos" and a new command, *showit*, was defined. The *showit* routine shows the text and then moves the cursor to a new location by translating (moving) the whole axis. Without going into a lot of detail, let me just say that moving by translating the axis makes it easy to write generic instructions for PostScript that are not tied to a specific location.

Axis translation can cause problems if you later want to move to an absolute position, because you may forget where your original starting point was and fail to compensate for it. For that reason, the *translate* commands are preceded by the *gsave* command and followed by the *grestore* command. These two commands allow you to do temporarily any axis translations you need and then restore everything to its original condition, eliminating any possible confusion.

Don't forget that the last command in your program must be a *showpage*. This is the command that actually puts the image on the page and ejects the page from the printer.

To use this program, all you have to do is send it to your PostScript printer. You can do this by using DOS's *COPY* command as follows:

COPY BRM35CRD PRN

which assumes that you've name the file BRM35CRD when you saved it out to your disk.

If you or your word processor have added an extension such as .TXT or

.ASC to the file name, be sure to include it when you use the **COPY** command. Also, if you're keying this program in with your word processor, make sure you save it as an ASCII or DOS text file, or you may have problems using it. If you have a

desktop publishing program, you may import this file into it as if it were a graphic image. Just indicate that you are placing a PostScript file. If you choose this route, add the extension .EPS to your file name, e.g., BRM35CRD.EPS. ■

Figure 1: *The finished product*



Note: Crop marks will print with reply card. Exact size of card, within crop marks, using measurements in PostScript Program Listing is 3.5-by-5.375 inches.

PostScript Program Listing — Business Reply Cards

```

%!PS-Adobe-2.0 EPSF-1.2
%%BoundingBox: 72 234 540 558
%%Title: Business Reply Card (3.5 by 5.375 inches)

% BRM35CRD

% This program will print a Business Reply Mail
% postcard that
% measures 3.5-by-5.375 inches.

% Data for Business Reply Card

(125)          % Permit number
(BROOKLYN, NY) % City and state for
               permit number

(ABC CONSULTING, INC.) % Return address line 1
(1234 - Any Street)    % Return address line 2
(Brooklyn, NY 11214-9990) % Return address line 3

% Routine to right justify text
/right {dup stringwidth pop neg 0 rmoveto} bind def

% Routine to center text
/center {dup stringwidth pop 2 div neg 0 rmoveto} bind def

% Routine to find, scale and set fonts
/font {findfont exch scalefont setfont} bind def

% Routine to merge to strings of text together
/mergestr {2 copy length exch length add
            string dup dup 4 3 roll 4 index length exch
            putinterval 3 1 roll exch 0 exch putinterval} def

% Routine to convert points to inches
/inch {72 mul} def

% Routine to draw a box from current location given the
% width and height
/box {exch dup 0 rlineto exch 0 exch rlineto neg 0 rlineto
      closepath} bind def

% Routine to draw the top left crop mark
/topleftcrop {/ymark exch def /xmark exch def

% Draw vertical line
newpath xmark ymark 36 add moveto xmark ymark
lineto stroke

% Draw horizontal line
newpath xmark 36 sub ymark moveto xmark ymark lineto
stroke} def

% Routine to draw the top right crop mark
/toprightcrop {/ymark exch def /xmark exch def

% Draw vertical line
newpath xmark ymark 36 add moveto xmark ymark
lineto stroke

% Draw horizontal line
newpath xmark 36 add ymark moveto xmark ymark
lineto stroke} def

% Routine to draw the bottom right crop mark
/bottomrightcrop {/ymark exch def /xmark exch def

% Draw vertical line
newpath xmark ymark 36 sub moveto xmark ymark
lineto stroke

% Draw horizontal line
newpath xmark 36 add ymark moveto xmark ymark
lineto stroke} def

% Draw bar code Style 1
/barcode1 {2 setlinewidth
            4.4375 inch 6.5625 inch moveto
            4.4375 inch 7.2125 inch lineto stroke

            4.5 inch 6.5625 inch moveto
            4.5 inch 7.2125 inch lineto stroke

            4.625 inch 6.5625 inch moveto
            4.625 inch 7.2125 inch lineto stroke

            4.75 inch 6.5625 inch moveto
            4.75 inch 7.2125 inch lineto stroke

            4.875 inch 6.5625 inch moveto
            4.875 inch 7.2125 inch lineto stroke

            4.9375 inch 6.5625 inch moveto
            4.9375 inch 7.2125 inch lineto stroke
            } bind def

% Draw bar code Style 2
/barcode2 {2 setlinewidth
            4.4375 inch 6.5625 inch moveto
            4.4375 inch 7.2125 inch lineto stroke

            4.5625 inch 6.5625 inch moveto
            4.5625 inch 7.2125 inch lineto stroke
            } bind def

% Routine to draw the bottom left crop mark
/bottomleftcrop {/ymark exch def /xmark exch def

% Draw vertical line

```

PostScript Program Listing — Business Reply Cards *(continued)*

```

4.625 inch 6.5625 inch moveto
4.625 inch 7.2125 inch lineto stroke

4.75 inch 6.5625 inch moveto
4.75 inch 7.2125 inch lineto stroke

4.8125 inch 6.5625 inch moveto
4.8125 inch 7.2125 inch lineto stroke

4.9375 inch 6.5625 inch moveto
4.9375 inch 7.2125 inch lineto stroke
} bind def

% Assign user supplied data to variables

/address3 exch def
/address2 exch def
/address1 exch def
/city_state exch def
/permitnum exch def

% Place the crop marks for a 3.5 x 5.375 inch card and
draw them

.7 setlinewidth
1.5625 inch 7.25 inch topleftcrop
1.5625 inch 3.75 inch bottomleftcrop
6.9375 inch 7.25 inch toprightcrop
6.9375 inch 3.75 inch bottomrightcrop

% Draw BRM box

0 0 moveto
2.5625 inch 5.75 inch moveto
3 inch .5 inch box stroke

% Draw stamp block

0 0 moveto
5.6875 inch 6.375 inch moveto
1.0625 inch .6875 inch box stroke

% Place the bar codes
% One of these 2 barcode lines should have a % in front
of it

% barcode1
barcode2

% Draw the horizontal lines beneath the stamp block

4 setlinewidth
10 {0 0 moveto
5.6875 inch 5.125 inch moveto
6.75 inch 5.125 inch lineto stroke
0 .125 inch translate} repeat
0 -.125 inch translate

% Place text in BRM box

18/Helvetica-Bold font
4.0625 inch 5.9875 inch moveto
(BUSINESS REPLY MAIL) center show

8/Helvetica font
2.75 inch 5.8125 inch moveto
(FIRST CLASS) show

4.0625 inch 5.8125 inch moveto
(PERMIT NO. ) permitnum mcrgestr center show

5.4375 inch 5.8125 inch moveto
city_state right show

% Place postage paid notice

9/Helvetica font
2.6875 inch 5.5 inch moveto
(POSTAGE WILL BE PAID BY ADDRESSEE) show

% Place no postage needed message in stamp block

gsave
/xpos 6.23 inch def
/ypos 6.9375 inch def
/showit {show 0 -.125 inch translate 0 0 moveto} def
7/Helvetica font
xpos ypos translate 0 0 moveto
(NO POSTAGE) center showit
(NECESSARY) center showit
(IF MAILED) center showit
(IN THE) center showit
(UNITED STATES) center showit
grestore

% Place mailing address

/xpos 2.6875 inch def
/ypos 5.125 inch def
/showit {show 0 -.1875 inch translate 0 0 moveto} def

12/Times-Bold font
xpos ypos translate 0 0 moveto
address1 showit
address2 showit
address3 showit

showpage

```


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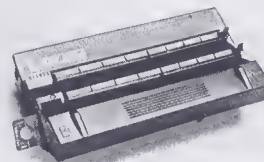
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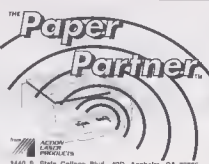
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